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ABSTRACT

This document contains the proceedings of the First National Energy Youth Conference held in 1974. These proceedings were compiled from both the prepared texts of speakers' presentations during the conference, and from tape recordings of discussion sessions and question/answer periods. Contents are presented in four sections: (1) Understanding the Energy Dilemma; (2) Increasing the Energy Supply; (3) Cutting Down on the Energy Demand; and (4) Towards a National Energy Policy. Student delegate energy resolutions, biographical sketches, and suggested readings and informational source sections are appended. The purpose of this conference was to establish communication between tomorrow's leaders and today's energy policy makers. (MB)

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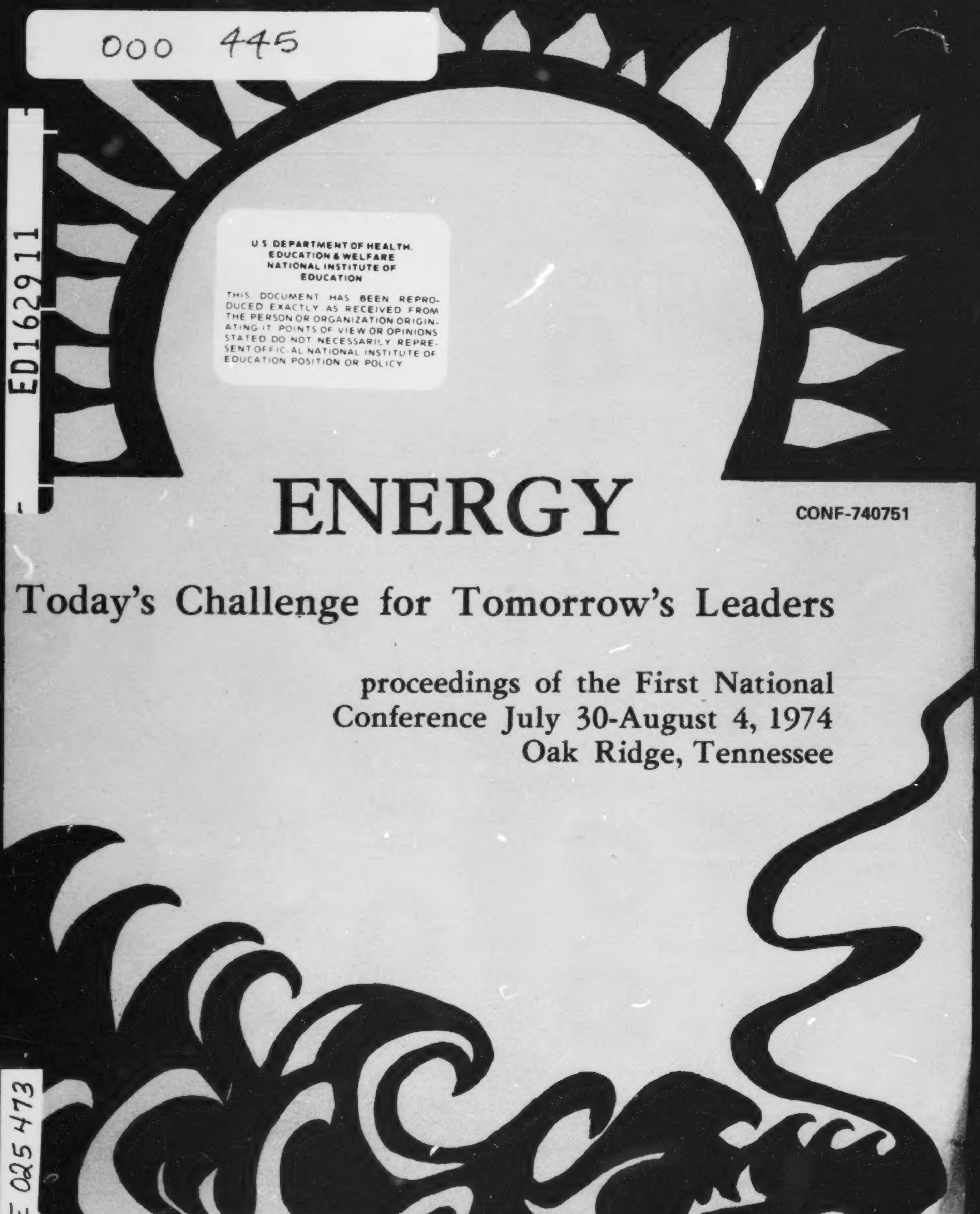

ENERGY

CONF-740751

Today's Challenge for Tomorrow's Leaders

proceedings of the First National
Conference July 30-August 4, 1974
Oak Ridge, Tennessee

SE 025 473

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First National Energy Youth Conference

Energy—
"Today's Challenge for Tomorrow's Leaders"

Proceedings for the National Conference,
July 30—August 4, 1974 Oak Ridge, Tennessee
Sponsored by Federation of Americans
Supporting Science & Technology (FASST)
with the assistance of the
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Co-edited by Patricia C. Dixon, Publications Director
Barbara Meyers, Media News Service Director
(FASST) March 1975

sponsored by the US Atomic Energy Commission

... To generations yet unborn, whose future depends upon our understanding of that which is addressed herein, and how we apply that knowledge...

PREFACE

The events of the past two years regarding energy clearly illustrate that energy management defines the immediate and more distant future well-being of humankind. The next period of ten to fifteen years will require the most from all of us who share this planet's resources to acquire, refine, distribute and use them as equitably and as carefully as possible. During this period also must come new resources, developed through conscientious applications of science and technology, that will reduce our energy management problems in the next century.

Our civilization is realizing the crucial necessity of balancing the impacts between our consumption of energy, and our maintenance of a clean environment. Whether at the personal, national, or global level of organization, this balance requires the understanding of, and involvement with, energy use policies by every individual. Policies made today will have effects not fully understood for several years, and thus, young people must involve themselves in understanding and helping shape these directives.

We, the youth and students of science, technology, society, and the future, have convened this first National Energy Youth Conference to learn from today's decision-makers in government and industry, from educators, from scientists, and from each other about the problems, solutions, and options available to aid in reaching an energy/environment balance. We have come here to convey our concerns to the leaders of energy policy so that future decisions can better reflect the interests of future generations.

As this Conference will serve as the starting point for new dimensions of youth involvement, we anticipate the future with a better understanding of our options, with better communication, and with new skills to be used in making the technological, economic, and social changes needed to reach a global energy/environment equilibrium. Our perspectives have changed, also, in our views of our role in the future. Involvement in the issues of energy management demonstrate the immediate nature of what comes from today's plans, and we have proven by our participation here, as tomorrow's leaders, that the future has already begun.

These proceedings were compiled from both the prepared texts of speakers' presentations during the Conference, and from tape recordings of discussion sessions and question/answer periods. While every effort has been made to insure accuracy and continuity of the transcripts, we regret any remaining incongruities or misinterpretations which may have occurred in this document.

To those many individuals who gave their uncounted hours and their labor to making the Conference a success, we owe our deepest appreciation. While to list those persons would be a voluminous task, we wish to express particular thanks to the following people: the many speakers and coordinating people from the Federal Government, Energy Industries, Utilities, and Universities who participated in the program; to Dr. Burrell Wood of the Energy Research and Development Administration for his personal help and guidance, and to Mr. Wayne Range, also of ERDA; our co-sponsors, the Oak Ridge Associated Universities, particularly Dr. Gary English, Dr. John Yegge, and Mr. Jasper Smith; those individuals, companies, and agencies who assisted with our tours of the Oak Ridge National Laboratory, the U.S. Atomic Energy Museum, the Union Carbide Gaseous Diffusion Plant, the Tennessee Valley Authority Strip Mine, Norris Hydroelectric Power Station, and the Bull Run Coal-Fired Power Plant, especially Mr. Harvey Cobert of Union Carbide, and Mr. James Myers of TVA; our hosts, Mr. Lyle Utterbach of the Oak Ridge Holiday Inn and Mr. Jim Alexander of the Alexander Motor Inn; and special thanks to Ms. Janine Prefontaine for enduring the frustrations of typing these Conference proceedings, and to the Oak Ridge Technical Information Center for assisting with printing; and particularly, our thanks to those persons too numerous to mention, without whom this would never have quite come together.

Roger Guisinger
Director, Energy Youth Council, FASST
(Conference Coordinator)

CONTENTS

Preface. iii

Conference Objectives. vii

Opening Remarks. 1
David M. Fradin

I. Understanding the Energy Dilemma.

"An Overview". 2
Francis X. Murray

The Energy/Environmental Simulator "A Time Machine". 10
Dr. Burrell Wood

The Energy/Environment Game. 16
Richard S. Scheetz

Student Originated Studies Program 17
Dr. Alfred S. Borg

II. Increasing the Energy Supply.

Increasing Gas Supplies. 19
Edwin F. Hardy

Fossil Fuels and Future Society. 30
Walter E. Kress

Panel Discussion: "Oil and Natural Gas Supplies" 35
Edwin F. Hardy and Walter E. Kress

Meeting Future Electric Power Needs. 42
Harold L. Falkenberry

Role of the Breeder Reactor in U.S. Nuclear Power Development 61
Peter S. Van Nort

Geophysical Energy Resources 71
Dr. Robert Cohen

Fuel Cells "New Options for Electric Generation" 106
James D. Brown

III. Cutting Down on the Energy Demand.

Reducing Energy Demand. 134
George Reeves

A Utility's Role in Energy Conservation 144
Ralph Marrone

Panel Discussion: "Energy Conservation" 154
George Reeves and Dr. Douglas C. Bauer

IV. Towards a National Energy Policy.

The Economics of Energy 161
Jack L. Schenck

Towards a National Energy Policy. 180
Kirk Hall

Panel Discussion: "Science and Technology Legislative Processes, and Youth Participation". 183
Kirk Hall, Thomas Hunt, and Dave Jenkins

Project Independence. 199
Donald L. Morris

Energy Conservation "A Federal View". 202
Dr. Douglas C. Bauer

Student Delegate Energy Resolutions 223

Biographical Sketches 228

Suggested Readings and Informational Source 256

9

NATIONAL ENERGY YOUTH CONFERENCE OBJECTIVES

To enhance the participants' understanding of the social, political, environmental, technical and economic aspects of the energy problem;

To enable the student participants to communicate with industry and government representatives about the various aspects of the energy problem;

To enhance the participants' understanding of what industry and government are doing and planning to do to solve the energy problem and the potential impact of these solutions;

To increase the industry and government representatives' understanding of student perceptions, knowledge, concerns, and attitudes toward the energy problem;

To develop the student participants' knowledge about the effective use of energy information sources (National Energy Clearinghouse for Students);

To enhance the student participants' organizational abilities in order to conduct a minimum of ten energy programs of their own choosing during the next school year; and

To enable the student participants to involve other students in energy problem studies to gain experience in organizational and research techniques for possible academic credit.

THE ENERGY PROBLEM
"TODAY'S CHALLENGE FOR TOMORROW'S LEADERS"

Opening Remarks,

by David Fradin, President
Federation of Americans Supporting Science and Technology

The young people of the United States, and the world, may be faced today with one of the greatest problems (I prefer the word--challenges) in history. Where will our future energy come from?

It is not a new problem. It was predicted to occur over ten years ago with superb vision and foresight by Presidential committees and others. But when asked why no one listened, the energy prophets could only recite history.

History--when Roman messengers brought bad tidings about how the battle went, they were usually decapitated--so too in our present day society, when bad news about long-distant future problems is brought forth it is likewise "decapitated," ignored, or even ostracized. As a result, the nation's youth suffers.

We shall begin to see at this conference how the probability exists that within our lifetimes (if we live to 80), according to Dr. M. King Hubbert of the U.S. Geological Survey, 80% of the world's supply of oil will be exhausted. That means, if we wish for the next generation to survive, we must begin to use other energy sources, or we will be doing to them the same injustice our predecessors have done to us.

In the next four days, you will have an opportunity to meet, discuss, and question some of the present-day leaders in energy. Notice that many of them are over 50. Notice, too, that many of them are telling us we can't have the liquid metal fast breeder reactor until 1985, solar energy until 1990, fusion power until way past the turn of the century. These men will not be around to know if their predictions come true. I propose that we must, in order for mankind to survive, move faster.

H. G. Wells once remarked: "The future is a race between education and catastrophy." In the next four days that race, for as far as we are concerned, begins. And how we take what we learn here and communicate it to our fellow students, young people, and citizens, in not only the U.S. but the world, will determine the outcome of that race.

UNDERSTANDING THE ENERGY DILEMMA
"An Overview"

Francis X. Murray, Assistant Director
Center for Strategic and International Studies

First of all, one of the objectives of this conference was to listen to the leaders of industry and government--now, I'm not from industry and I'm not from government; I'm from Georgetown University from the Center for Strategic and International Studies. We have an organization interested in domestic energy problems, and one of our goals is, hopefully, to educate people regarding the energy dilemma, as we call it. That's the purpose of my being here today, to give you some understanding of the national energy problem that we currently face. What I'd like to do is provide a framework or a logical structure within which you can view the problem, and relate the various pieces and parts of it to each other. It is a very complex problem, and many of the parts have interrelationships which are essential to understand. Also, I want to give you some appreciation or feel for how we got to where we are and what the prospects are for the immediate future and for the longer term future. By immediate future I mean five years--that's a long time to you people. It's not for me. And some day it won't be very long for you either.

Now, to do this we have developed a model or display technique which makes use of the basic engineering flow charting concept--it's called a spaghetti chart. It takes the various supply and demands of the basic energy resources which include coal, oil and gas. It looks at the various conversion processes such as electric power generation, coal gasification, coal liquification; it looks at the classical consumers of energy such as the commercial and residential sectors, the industrial sector and transportation; and finally it shows the efficiency with which we use energy.

Now, to make some sense out of this, we have to use a common denominator--we have to relate the elements to each other. What we're using is a million barrels of oil per day as the standard unit of measure. You know we use the term "millions of barrels of oil" very glibly; but, a gallon of gasoline used to generate electricity will generate 15 kilowatt hours. Well, you say 15 kilowatt hours, so what? The way we run through electricity that's probably true. But 15 kilowatt hours is equal roughly to 15 man days of hard labor, that's fifteen man days. And one barrel of oil is equal to about 630 man days. That's almost two man years of effort. That's a lot of energy. We're going to be talking about millions of barrels, per day. So keep that in perspective. That's a tremendous amount of energy--that's a tremendous amount of power that we use every day in our lives.

12

The internal combustion engine is notoriously inefficient; under the best of conditions it will operate at only 25% efficiency. A heavy American car on the highway at 70 miles an hour will operate at less than 10% efficiency. And if you put that same car in the midst of a traffic jam in town, it probably won't even do that well.

This is a gloomy picture; maybe it's overly so. I didn't intend to try and make it look nice and make you feel better. After all, we believe that we really are facing a very serious problem. In addition, I feel that we let a tremendous opportunity slip through our fingers early this year. You know, the Arabs took a two by four and wrote "boycott" across it and they hit us right between the eyes, and we barely blinked. Now, we're going right back to our old ways, right back to our old methods of doing things. We're getting right back to the trough; back to even higher levels of energy imports. And it raises some very serious and fundamental questions which you people are going to look at for the next couple of days. Such as--Can we conduct our foreign policy, or foreign relations, our national defense in a world where we are confronted with the prospect of having the life blood of our economy cut off? This we experienced to an extremely limited degree this spring when we were importing roughly a million and a half barrels of oil a day from the Middle East. (The figures are hard to come by, but it looks roughly like a million to two million barrels.) That isn't very much, but it created havoc with our system. Petroleum is essential to a modern industrial society. Can we control our destiny if someone has his hands around that life line?

Another question. If we're going to import 7, 8, or 10 million barrels of oil per day, 5 or 10 years from now, where are we going to get the money to pay for it? The Arabs won't give this away out of generosity or charity. We haven't in the past when we've sold oil. Where are we going to get the 20, the 30, the 40 billion dollars a year to pay for those imports? It's not only from the Arabs, it's from all the oil producing nations.

Domestically we face certain very basic fundamental problems: energy and environment come into conflict every time they meet. We talk about our fossil fuel base being three quarters coal; yet coal and the environment conflict every time they meet. You're in trouble when you mine it, when you burn it, and when you're through you've got the ash, and you don't know what to do with it. Coal represents an extremely important technology challenge as to how to use it in an environmentally acceptable way.

In terms of the social and political aspects of the problem, the historical relationship between energy consumption and Gross National Product and employment and standard of living are very clear. We have an economy, a society and a way of life which has grown up and thrived on abundant and cheap energy. We may be asking it now to turn completely around. There's tremendous inertia in the system and it isn't easy to turn a system like this around. It is extremely important that the effort begin. When people talk about conservation of energy later on in the program, it's extremely important; but remember, it isn't going to be easy. Conservation will be an important part of our efforts to bring our energy demand into balance with our supply capability. And remember, for every barrel you don't need in terms of useful energy, that means one more that you don't have to burn because of inefficiency losses.

Finally, there's some very unattractive political questions that are raised by this whole energy problem. There's the environmental question, there's the economic question, and there's also the redistribution of resources and wealth. You know some people very cavalierly say, "Well, just let the price of energy sources rise and let supply and demand take charge, and everything will get into balance." I don't think we live in a society which will permit those with wealth and money to have all the energy resources and those without, the poor, do without. I don't think you have to be a radical leftist to say that's an unacceptable political solution.

Finally, there's the real challenge of the whole energy problem and that's the challenge that comes with technology. This is a problem that's amenable to technology. It's going to require tremendous effort and probably investments for it to be resolved. That's the real challenge of our energy situation...that's the real hope...that's the part you people should be interested in. Why don't I stop there and we'll open it up for ten or fifteen minutes of questions.

Editor's Note:

For additional clarification, please refer to the Joint Committee on Atomic Energy's 1973 report: "Understanding the 'National Energy Dilemma'" which reprints the CS/S. graphic overview of the Total Energy Flow Patterns (1950-1990). The report is for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D. C. 20402, price $1.55, stock number: 5270-01947

QUESTION AND ANSWER SESSION

"Understanding The Energy Dilemma--An Overview"

Speaker: Francis X. Murray

DELEGATE: I've got a couple of questions, but first I want to stick in another element that I think probably a lot of students particularly don't consider. The Arabs have the oil power in terms of politics, and we've seen they're willing to use it. Let's suppose not only that they choose to institute a political boycott, not necessarily related to the Arab-Israeli question, but for their own personal-political reasons. Let's take also into account the fact that the Soviet Navy is at present the world's most powerful and has a dominant influence all across the areas that are critical to the U.S. transport system, mainly the Persian Gulf, the Indiana Ocean and the Mediterranean area and finally throw into the equation the fact that the United States Navy is now the second rate naval power, and, in fact, decreasing in strength steadily with the passing months. Take that scenario and suppose that the Arabs and the Soviets get together and decide to strangle the U.S., cut out the oil for a period of years deliberately to cause economic collapse in this country, what have you got? Our energy problem is a hellava lot more than simply an economic one or a problem of whether or not we can continue the kind of life we've had before. I would say that long before we reach the stage where the country will economically collapse simply because of balance of payments problems, we will reach a strategic crisis which could very well force the U.S. to make a military decision to either go to war with the Soviet Union or to give up its present place as the world's leading power permanently. So, I think that all of us ought to consider that very military question as well as the economic and political ones.

MURRAY: What you describe is a very unpleasant situation. I think there is a more direct parallel. The Indian government decided this past spring to go ahead and detonate a nuclear device. I think it was a very conscious decision made at the highest political levels in India. You have to ask yourself "WHY?". India is facing a tremendous food crisis this summer and fall, and it's been aggravated by the energy crisis, and the lack of both petroleum products and fertilizers which are generally petroleum based. This may well have been a signal. You know there's a limit to what the Indian people will tolerate in the way of being deprived of very basic resources to sustain life. And, while, that's speculative; why else would they have gone ahead and detonated the device? You really have to ask yourself that question, so there may be more subtle applications of the same type of problem. I don't know that it has to be a major conspiracy to get almost to the same scenario you were postulating.

This fall in Geneva the Arabs and the Israelis are going to sit down and try and arrange a political settlement to the current military standdown. The political questions have not been resolved. Now the question is what will happen if the political differences cannot be resolved by the belligerents? Are the Arab nations going to go back to the policies which they used last fall? Are they going to reduce production a little bit? Are they going to boycott certain nations? Or Maybe they'll just allow production to remain stable and not increase with the growth in demand. We've seen the chaos which this type of policy can create; and we're in no position to help out other nations at the moment regarding petroleum. We have a problem of our own. And Japan and Western Europe are five or ten times worse off.

DELEGATE: I have one about the demand graph. Just any of those. On every one of them there is a dip in the curve around 1977. I was wondering what caused that in oil, gas, and other items in our domestic supply?

MURRAY: It's flattening out is what you really mean.

DELEGATE: Well, on your other graph it's really obvious that there's a dip.

MURRAY: That's an optimistic view.

DELEGATE: Do you see that decrease?

MURRAY: There is a tailing off of the domestic petroleum base. What this is doing is really predicting that the lower forty-eight sources of petroleum will continue to decrease as they have been doing for several years. And it isn't until you have the Alaska pipeline, and then begin to bear the fruits of the recently initiated exploration in the lower forty-eight and off-shore that you begin to see that line stabilize then increase with the Alaskan oil addition. So really, it's just a continuation of the decrease in production from the existing continental resources of the lower forty-eight states, than an increase in the late 70's which causes that apparent anomoly.

DELEGATE: O.K. What about coal and domestic gas?

MURRAY: Coal is running at roughly the same level--then begins to increase in the 1970's. What you're seeing here in natural gas is a pick-up of imports to support gas needs rather than domestic sources, so it does make for a funny picture.

DELEGATE: O.K. Something else just for an idea is--do you have any numbers on the terms of dollars on how much we spend on imports--you know, including both liquid petroleum and gas?

MURRAY: Well, we're running at an annual rate right now on imports of liquid petroleum products of about eighteen billion dollars. I don't know what the natural gas imports are costing this year.

DELEGATE: Does that average approximately eight dollars a barrel or something like that or is that closer to four?

MURRAY: Right now, I'm sure it's eleven sixty-five or close to it. But, you know if you had a full year of imports at that price, the value of these imports would be even higher.

DELEGATE: I've just got one other question--do we have any estimates on what the fossil fuel supplies are in the communist countries--have they given us anything?

MURRAY: I've seen some but I don't know how good the figures are. On fossil fuel bases for the free world, there are several estimates. Just take the U.S. for example--the difference in recoverable oil resources projected by various people runs from about four hundred billion barrels to about one-third that level. The U.S. Geodedic and Coastal Survey has a range from four hundred as a high to two hundred as a low--that's a large difference right there just in their own estimates; this gives you an idea of the degree of uncertainty--and that's ultimately recoverable and economics are a somewhat vague consideration. Other people such as King Hubbard, which you may have heard mentioned before, estimate that we only have eighty to one hundred billion barrels--in terms of remaining recoverable supply. There are many different methods of estimating the available oil in the U.S. Interestingly enough, it's the U.S. Geological Survey which is coming down, not Hubbard who is going up.

DELEGATE: You've shown us a bunch of projects based on present trends.

MURRAY: Right.

DELEGATE: Now, I think there are going to be a lot of other factors influencing these trends. What do you think that will result in say five or fifteen years?

MURRAY: O.K. I think you really have to understand how these projections are constructed. They don't just take resource consumption and project a rate--they take our past history of resource consumption and relate it to about a dozen or more key variables such as population, the number of automobiles, the miles per car, the average miles per gallon, the number of dwelling units that have to be heated, the floor space, and it goes on and on. All these key variables are cranked into these projections. Now, what they do assume basically is that we do make some progress in improving energy utilization. Interestingly enough, they assume, for example, that by 1985 in this particular estimate that we'll have over a million electric cars on the road. They also assume that we will be getting on the average over twenty miles per gallon. That's also interesting. Half the cars that are going to be on the road in the year 1980 are already on the road today. 90% of the dwelling units that are going to be heated in 1980 have already been built.

It takes eight years to construct a nuclear power plant; it takes five years to build any kind of rail network be it urban or inter-state. It takes five years to open up and fully develop a new oil field or gas field for significant production. It takes several years to build a refinery and you can go on. The point is that the system has tremendous intertia built into it--it's a tremendously large base--it takes time to turn it around. So you know, there's good grounds for saying if we just go about our business, this is where we'll end up. And you know, people's habits are also factored into the projection and they're part of this, too. But, they are projections and they can be changed, but it's going to take a very definite and determined effort. We lost a golden opportunity this spring--I don't know if we'll get another one. Then, people were mentally and psychologically ready, and I believe they really would have made the efforts. They were willing to make the sacrifice but were not called upon to do so. I think we're going to regret not taking advantage of it.

DELEGATE: You predict that nuclear power will be used deliberately and far in the future. If you try to put in more money--try to convince people that nuclear power should not be used, could this trend be changed?

MURRAY: Regarding the use of nuclear power?

DELEGATE: Yes. Because there seems to be very little of the energy that will come from nuclear power in the next few years.

MURRAY: Well, there is a significant role. If you'll notice on the chart--after all, don't forget in 1970 the energy input--the equivalent energy input we would have had to make in oil to generate the same power we obtained from nuclear power was about a hundred thousand barrels of oil per day--that isn't very much. This was roughly equal to the amount of energy we received in 1970 by burning firewood. So, you know it's an infant industry. We're projecting significant growth during the 1975-1990 period. And, in fact, this projection appears to be optimistic right now. Nuclear power plants themselves are extremely expensive. We were up at the Peachbottom Number Three Unit of the Philadelphia Electric Company not too long ago. That's more or less a standard size boiling water reactor--it's about 1100 megawatts. Construction alone for that plant when it's finished--and it's 90% complete--so the estimate is very reliable--is going to run about seven hundred sixty million dollars. For one unit.

One unit. That's only the generating plant itself--it's the third one at the facilities which were there for the other two units. It doesn't include the transmission--it doesn't include the distribution and all the other equipment and it doesn't include the fuel. That's a tremendous amount of money. And, current projections put out by the Atcmic Energy Commission (AEC) on what they believe the industry will do by the year 2000 indicates that the level of nuclear power will probably be somewhere between a thousand and twelve hundred of those types of plants in this country. You know, if you do a little quick mental arithmetic, that comes out to almost a trillion dollars of capital investment if the plants cost anything like the one at Peachbottom. And there's nothing particularly fancy about the Peachbottom plant.

DELEGATE: What is the difference between building costs for a nuclear plant and fossil fuel plant? How much do fossil plants cost? Do you know?

MURRAY: I'd like to have the same company do the estimate because then you would know they were using the same general considerations in the same time frame to arrive at the decision to go either nuclear or fossil. What you end up with is one person building a fossil plant here and another person building a nuclear plant there. From estimates I've seen it appears that the current fossil fuel plants of comparable size might run today about 300 million dollars. And that's very guessy because the conditions are not the same.

DELEGATE: Is that considering environmental protection?

MURRAY: Yes. The necessary environmental protection they have to put in. Systems to control fly ash and SO_2. One of the big problems with fossil fuel plants is once they're built; then you continually are faced with the operating cost of fueling. And I know the Philadelphia Electric Company has done a very thorough economic study and despite the tremendous investment required for the nuclear plant, they still feel, for their particular situation, it's more economical. That's their set of conditions that determine this. Being as it's 90% complete, I wouldn't expect them to tell me anything else now anyway, because, they would not tell me, "Hey, we really loused up here." When they initially did the study, they didn't expect the plant to cost near that much. However, fossil fuel prices have also increased dramatically.

DELEGATE: I'm sort of interested in following up on these estimates that you have up there that you've been telling us all about. Especially in relation to the population of--you know, our country now is supposed to be moving towards population control. Well, in the Washington area in particular we've reached Zero Population Growth (ZPG) and it's hoped to spread nationwide. If we do slow down our population growth drastically, wouldn't also our energy needs be affected and wouldn't these estimates of yours be considerably off?

MURRAY: O.K. Before you take great consolation, let me tell you a few things about this. First of all, it's based on a compromise of Series D and Series E Population Projection from the Census Bureau. So, it's high in terms of today's birth rates. By the year 2000, the assumptions that underlay this model indicate a population probably 10 or maybe 15 million higher than we may experience if the present rates continue. However, there are some offsetting trends as well.

Household formations which includes single people as well as married couples has actually increased above the estimate projected by the Census Bureau. And interestingly enough most of them are for single persons. And you know how your swingers burn up energy with a car, TV, a Hi-Fi, and away we go. So, there are some offsetting factors. The point is that the fact that population is not growing as fast as we thought even just a couple of years ago may not materially reduce energy demands in the next ten years. That isn't going to be the big difference. In the long run, the birth rates are important; you're right. That is a tremendously important thing when you talk about the year 2000.

DELEGATE: Another question. We've been seeing a lot of ads recently on TV from some of the big oil companies like Mobil or someone like that--They've been working very hard on their offshore drilling and this and that. You know, very American-type ads, and I've been wondering--your charts are showing that the domestic oil in the forty-eight states is to be going down, and about 1977 it's going slowly down, but it's down, and I really wonder, are they deceiving us or what? What's the problem there?

MURRAY: Well, I think there are two differences. First of all, the supply is based on the assumption that there will be significant development in the lower forty-eight and offshore areas. The onshore sites for petroleum production are declining in the U.S.; they're mature and production is going down. So just to stay even, you have to supplement that with other sources. Now, we've turned to the Gulf of Mexico. So, in effect, the offshore production is replacing the continental onshore capability which is petering out.

DELEGATE: It's really a measure of our capacity, then? What they're saying is that they've gotten this much extra oil out of this plant and this and that, and they're just trying to present the most optimistic picture and it really isn't that way?

MURRAY: You might raise that question later when the gentlemen from Shell Oil will be here.

DELEGATE: O.K. One last question, You were saying that we had a great opportunity this spring--everyone was in a good psychological mood to cut back, but the figures barely went down--now they're going back up again. What were the exact figures and how much did our consumption go down during the energy crisis?

MURRAY: I wish I'd brought my book of charts. We went down probably below sixteen million barrels a day during the spring. We're now back up to about seventeen or a little more. The actual consumption is hard to figure because the data really only shows final sales.

You know a lot of people put in extra tanks and all that business...which may have indicated consumption when it's really home inventories, so, the accuracy of the figures has to be questioned...but the data we do have indicates that there's been a growth of about two million barrels per day since that crisis atmosphere during the spring.

DELEGATE: Are we back above now where we were before the energy crisis?

MURRAY: We're just about right on the line with where we were last summer. Consumption in July, 1974, is about equal to the July, 1973 level. The figures I saw last week just crossed over...so we're just about back where we were. Of course, getting people to change their habits and their life-styles is a matter of psychology. The proper psychology was there this past winter; people were willing and ready to make a sacrifice; however, they were not called upon to do so.

THE ENERGY-ENVIRONMENT SIMULATOR
"A TIME MACHINE"

Dr. Burrell L. Wood, Office of Information Services
U.S. Atomic Energy Commission

Editor's Note:

The following is an explanation of the Energy-Environment Simulator, which was developed by the Oak Ridge Associated Universities, and presented to the delegates for their participation during the conference.

The Simulator is available to interested groups through:

Mr. Melton Moore, U.S. Atomic Energy Commission, San Francisco Operations Office, 1333 Broadway, Wells Fargo Building, Oakland, California 94616.

Dr. Bruce Nimmo, Associate Professor of Engineering, Florida Technological University, Orlando, Florida 32816.

Dr. Paul W. Barcus, Assistant to the Dean of Engineering, Iowa State University, 104 Marston Hall, Ames, Iowa 50010.

Dr. Leland L. Wilson, Head, Department of Chemistry, University of Northern Iowa, Cedar Falls, Iowa 50613.

Dr. Burrell Wood, Office of Information Services, Energy Research and Development Administration, Washington, D. C. 20545.

Dr. J. Kenneth Shultis, Associate Professor, Nuclear Engineering Department, Kansas State University, Manhattan, Kansas 66506.

Dr. Paul Kramer, Physics Department, C.W. Post College of Long Island University, Greenvale, New York 11548.

Mr. W. H. Steigelmann, Manager, Energy Systems Laboratory, The Franklin Institute Research Laboratory, The Benjamin Franklin Parkway, Philadelphia, Pennsylvania 19103.

Dr. Bryan Valett, Director, Northwest College and University Associate for Science, 100 Sprout Road, Richland, Washington 99352.

Dr. John Yegge, Oak Ridge Associates Universities, P.O. Box 117, Oak Ridge, Tennessee 37830.

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This electronic game was developed during the spring of 1973 for the Atomic Energy Commission by Oak Ridge Associated Universities in Oak Ridge, Tennessee. Its purpose is to allow anyone to take control of our total energy situation and make decisions regarding the use of fuel resources and energy uses for our country. It has the unusual characteristic of allowing the participant to see the results of his decisions both in terms of the effects on the environment and in the number of years that will be remaining before each of the fossil fuels run out.

In order to play the game meaningfully, one should have a good understanding of the interrelationships between the production of energy, the use of energy and the effects on the environment. The game is actually a laboratory-like experience in which the participant tests his understanding of the varied factors with which we must deal in handling the energy problem. It forces the recognition of the inexorable consequences of the decisions we make or don't make in the area of energy production and use.

The game does not provide for the development of new sources of energy or new technology for older sources of energy. It was felt that one should develop a clear understanding of why we have an energy problem and the complexities of dealing with this problem before intelligent consideration of the possibilities and necessity for new technical advancement could be given.

The ways of playing the game are limited only by the imagination of the individuals directing the operation. The varied approaches can be placed in three categories:

1. Those involving more intelligent use of our energy resources.
2. Those involving more intelligent use of energy itself.
3. Those involving more intelligent protection of the environment.

Of course, combinations of the above can also be used. In any case, the game can be used as a very powerful tool for teaching and for learning.

The inescapable conclusions, after playing the game effectively, are:

1. There is no way under the present situation to avoid running out of fossil fuels.
2. We must give every effort possible toward intelligent use of energy and our energy resources.
3. It is of utmost importance that we move forward as rapidly as possible with the development of new sources and of new technology for the production and use of energy.

A GUIDELINE FOR USING THE ENERGY-ENVIRONMENT SIMULATOR

The simulator is a real-time display that places an audience in the position of having to make some important decisions about energy supplies, distribution, and uses so that the members of the audience are in the predicament of having to live with the consequences of their decisions.

The format for using the simulator with an audience described here was developed over several dozen uses of the device. This protocol has proven to predictably elicit certain desirable responses from an audience that are not easily elicited by persuasion or arguments.

Introducing an Audience to the "Time Machine".

What needs to be said about the various areas of the game depends largely on the audience--their sophistication; whether they have been exposed to, for example, a slide presentation on the general topic; or the amount of time they have to devote to the simulation. (There is a big difference, for example, between a captive audience in a classroom for 50 minutes, and a casual audience browsing an exhibit hall.)

Useful topics to discuss (at some point prior to starting the game--either in a slide presentation, or at the beginning of the simulation session, or both) are:

(1) The Time Clock: Hurtles the audience forward through time at a rate of 100 years per minute. (If your machine has a control for regulating the speed of the clock, the time rate should be kept at about 100 years/min or the other parameters such as fuel reserves will be out of calibration as the clock is independent of fuel resources.)

(2) Energy Sources: The world's principal energy resources are displayed across the top half of the game board. A reserve meter in each area shows the amount of fuel that remains (like a gas guage). Turning up the rate of use knob depletes the resource faster just as stepping on the accelerator uses up your tank full of gas faster. Of course, hydroelectric and geothermal are never exhausted but the rate at which energy can be drawn from them is realistically low. Energy sources, that are technologically or economically unfeasible in 1973 (solar, tidal, fusion, etc.) are not displayed on the game panel.

Hydro, Nuclear, and Geothermal energies are used almost exclusively to generate electricity so that all of the energy from these areas is delivered to the Electrical Energy Pool for distribution to all of the demands that use electricity.

(Notice that the colored stripe on the hydro, nuclear, and geothermal areas matches the border around the Electrical Energy Pool.)

Fossil fuels are capable of generating either chemical energy (burning coal for heat, gasoline to move your car, etc.) or electrical energy. Slide levers below the coal, petroleum, and natural gas areas regulate the proportions of each of their energies delivered to the two pools.

(3) Energy Demands: There are three major categories of energy demands.

(A) Industry--Containing the following representative elements:

(i) Steel (and Aluminum)
(ii) Refining
(iii) Mining
(iv) Chemical
(v) Agriculture.

The slide lever below the industry area regulates the fractions of the energies for industry coming from the chemical and electrical energy pools.

(B) Transportation--Containing the following representative elements:

(i) Automobiles (gasoline powered)
(ii) Automobiles (electric)
(iii) Trucks and buses
(iv) Railroads (gas or electric)
(v) Airplanes.

(C) Household and Commercial--Containing the following representative elements:

(i) Heating (gas or electric)
(ii) Air conditioning
(iii) Lighting
(iv) Hot water (gas or electric)
(v) Appliances.

(4) Environmental Impact:

(A) Thermal pollution (with contributions coming from coal, petroleum, natural gas, and nuclear power);
(B) Air pollution (with contributions coming from coal and petroleum); and
(C) Radioactivity (with contributions coming from coal and nuclear energy).

Later models also have:

(D) Population density (governed by the length of time the population browth switch has been "on"); and
(E) Personal Energy demand (governed by the settings selected in the demand areas and how long personal energy demand has been growing).

(5) Growth Controls: There are two growth controls.

(A) Population

(B) Personal energy demand control.

With both controls "off," no growth occurs. With either control "on," and the other "off," a linear (or arithmetic) increase in energy demand occurs. (And in later models--personal energy demand meters in the two energy pools display the results of growth or stability controlled by the personal energy demand control.)

(6) Energy Pools: Energy must be supplied to the energy pools fast enough to meet the demands being placed on them. A shortage in either pool is displayed either by an illuminated "minus sign" or a labeled meter, an illuminated red light labeled "energy shortage," and an audible alarm. Balance may be established by increasing energy supply from an appropriate area (note that chemical energy cannot be obtained from all areas), or by decreasing an appropriate demand, or by reallocating the energy supply from the fossil fuels.

If energy is supplied to either pool substantially faster than it is needed then a "plus sign" is illuminated in the appropriate pool or the result is displayed on a labeled meter. Here again, energy supply, energy demand, or allocations may be changed to bring the system back into equilibrium (illuminated "ok" or needle in the white region on the balance meter in the pools).

In a sense, the players are asked in part to play the role of the feedback device in power plants that senses increases or decreases in demand and raises or lowers energy production appropriately.

Setting Up The Simulator For Use.

(1) Disconnect satellite controls (if any) from main console by unplugging them at the console.

(2) Set the three toggle switches on the right-most card (as seen from the back inside console) to the "off" position (toward you). (This gives full weight to the controls on the console. Later on, these switches will be used to distribute control of the game to several locations.)

(3) Stop the time clock, if it is running, with the "time suspend" switch (unlabeled) in the lower left corner of main panel.

(4) Press "reset" to zero clock and re-establish energy sources. Recheck item 3 above.

(5) The Simulator is a decision-making game and, as such, any settings are valid if the players feel they could live with them. Proportions of supply and demand simulate 1973-74 when set up as follows:

(A) Supply:

(i) Coal ↑
(ii) Petroleum ↑
(iii) Natural gas ↑
(iv) Hydroelectric ↑
(v) Nuclear ↓
(vi) Geothermal. ↑

(B) Demand: All demands except electric automobiles which are ↑ turned "off."

(C) Fossil fuel distribution and industry demand levers: Adjust to middle position until both pools are in balance. Small increases in energy supply areas may be needed here as well.

(D) Growth control switches: Set population growth to "on" and personal energy demand to "off." On earlier models, there is only one growth trol on the front panel. A second switch inside converts otherwise linear growth to exponential growth. (Inexperienced players usually find exponential growth very difficult to manage.)

The game is now ready for use with the main control panel having the full control of the game. Turn the game "on" with the "time suspend" switch and you are careening through time at a rate of 100 years per minute.

If satellite control panels are to be used, the toggle binary switches on the right-most card as seen from the rear should be set to sum to the number of control panels to be used, and the remote control panels should be plugged (through a junction box if there is one) into the main console. It seems to be good psychology in working with an audience to turn the control knobs of the main console to "off" at this time to put the entire control into the audience. A convenient way to determine the appropriate settings for the three binary switches is:

(1) Set all remote controls as described on the previous page.

(2) Turn off controls on main panel.

(3) Try different combinations of the three toggle switches on the right-most card until the personal energy demand meter reads about 80.

Getting An Audience Into The Game.

There are as many different ways of using the simulator as there are users. We suggest here only one effective use of the device to get the new user started.

The above discussion was intended for the professional user, not the general audience. In general, we urge that the group leader say as little about the game and its controls as he can get away with; learning occurs much faster while the game is running--and it makes more sense to the players to get information as they need it rather than as a big wad dumped on them all at once.

If there is 30-60 minutes to spend with an audience, it seems to be a good idea to take the first 5-10 minutes identifying the major areas of the game:

(A) Clock (100 years/min).

(B) Energy sources.

    (1) Fossil fuels 96%;
    (2) Non-fossil fuels 4%; and
    (3) Guage shows reserve remaining in energy resource areas.

(C) Energy pools.

    (1) Non-fossil fuels contribute to electrical pool only;
    (2) Fossil fuels contribute to either pool or both pools;
    (3) Balance display ("ok," "+," "-"); and
    (4) Discuss personal energy demand later.

(D) Energy demands.

(E) Environmental impacts.

(F) Growth controls.

First run: The first run of the game is often turbulent as players learn their way around their control panels. They learn, essentially, which energy sources supply which pools, and which demands draw from which pools. They should be informed that the energy allocation levers in the fossil fuel areas are only on the main panel and that they are changed by asking the director. The same holds for the lever governing where energy comes from and to the power industry. They have all other controls except growth controls.

The fossil fuels usually run out in 200-500 years, at which point the game ends because the chemical pool has no more input of energy and the alarm can no longer be silenced.

If the audience is dismayed because "they blew it" they are set up to be asked a crucial question preceding the second run.

Second run: Our experience has been that the harrowing trip through time gives most audiences a common bond, gets them talking with one another, and opens--of necessity generated by their common crises--channels of communication and willingness to consider some alternatives.

It is a rare group that has an individual who realizes that the key to success (i.e. longevity) in the game is in allocation of fossil fuel energy to the two energy pools and allocation of energy demand (especially industrial) to the two energy pools. One might open the discussion in this fashion:

> "Where do we get into trouble fastest? Right. The fossil fuels. Let's look at how we've been using our energy from fossil fuels: partly as chemical energy and partly as a source of electricity. Is that what you really want?"

. . .

> "Correct! Why burn fossil fuels to produce electricity when we could use energy sources for electricity (hydro, nuclear, geothermal) that do not run out so fast?"

Move fossil fuel allocation levers to direct all energy into the chemical pool. One might continue:

> "Do we want to continue powering our industry heavily by the very finite reserves supplying the chemical energy pool? Of course not. Let's use the relatively abundant non-fossil energy sources supplying the electrical energy pool."

Move industrial lever to draw heavily from the electrical energy pool. Individual players may elect to draw more heavily from the electrical energy pool in other areas:

(1) Electric cars replacing gas cars
(2) Electric railroads
(3) Electric heating
(4) Electric hot water.

We must stress here that the trick is not simple conversion to electricity. It must be accompanied by increased use of non-fossil energy sources.

A combination of these changes and of the experience gained in the first run of the game makes things go considerably smoother in this run. On this run roughly half of the groups succeed in conserving fossil fuels so that some remains after 1,000 years on the clock.

Third run: By this time, the players usually have the game well in hand and an increase in realism is desirable. Since energy demand has grown exponentially for more than 120 years, a continuation of that kind of growth into the future may be achieved by turning on both population growth and growth in personal energy demand. The run is frenetic but it drives home the problems encountered when a finite system tries to support an exponentially growing subsystem. Something has to give way because the two are basically incompatible.

THE ENERGY-ENVIRONMENT GAME

Richard S. Scheetz, Educational Services
Edison Electric Institute

OVERVIEW

The Energy-Environment Game is an educational simulation that deals with society's demand for increasing amounts of energy and the complex problems that result from this demand. The simulation is a problem-solving and decision-making model.

The actual play of the game revolves around an electric utility company's request to build a new power plant. A governor's commission considers the plans for a new plant--and an actual site for the plant--in a series of open hearings and through citizens' task forces.

The players assume roles ranging from the utility company president to the leader of an environmentalist group opposed to new plant construction. Playing the roles, they present views at open commission hearings and join task forces to help solve the difficult problem of selecting trade-offs involved in meeting society's demand for more energy with an inevitable environmental impact. The game concludes with the governor's commission making its formal recommendations concerning the need for and site of a new plant.

Although the players are involved in discussing sites for a plant, this is a tactic of the game and is not the objective of the game. The objective of the game is to consider in macro terms society's demand for energy, potential impact to the environment, and possible trade-offs.

This simulation program does not in any way or form give answers to the problems raised. It is intended as an introduction and as a forum for discussion.

PROGRAM OBJECTIVES

The specific objectives of the simulation are:

1. To help the players understand society's needs and requirements for electric power;
2. To help them identify and understand the complexities and important responsibilities involved in planning for society's future needs;
3. To enable them as responsible citizens, to analyze objectively the ecological, technical, economic, and political considerations and trade-offs in planning future power plants; and
4. To provide substantive information relating to electric power generation including population, environmental and economic growth, socio-economic problems, and concepts of regional planning.

Perhaps the most desirable result of the program would be to have people realize that there are no easy, simplistic, readily available solutions to the problems that face us.

STUDENT ORIGINATED STUDIES PROGRAM

Dr. Alfred F. Borg, Group Director, Student Oriented Programs
National Science Foundation

Editor's Note:

The following is an explanation of the National Science Foundation's Student Originated Studies (SOS) program.

This presentation was made during the Conference to acquaint the delegates with an opportunity for them to become more involved in finding solutions to environmental challenges.

More information may be obtained by contacting:

Dr. Alfred Borg, Group Director
Student-Oriented Program
National Science Foundation
5225 Wisconsin Avenue, N. W.
Washington, D.C. 20550

The central objective of the National Science Foundation's Education Directorate is to help assure an appropriate number, variety, flexibility, and quality of professional, scientific, and technological manpower. One activity contributing to this objective is Student-Originated Studies (SOS), a program designed to take advantage of the strong motivation felt by students in pursuing scientific problems of their own choosing. The general aim of SOS is to provide students experience in independent, self-directed study, and to demonstrate the effectiveness of such study as an adjunct to or replacement for portions of their traditional formal course work.

The following are some salient characteristics of SOS:

* Each project proposed is to be problem-oriented to deal with a local problem that has immediate relevance to the community; that is concerned with the biological, physical, or social environment; and that poses yet-unanswered questions of a scientific or technological nature on which the student group can collect meaningful data.
* The approach to understanding the problem(s) and the search for solution(s) are to be interdisciplinary or multidisciplinary in nature, hence;
* Each proposed study or set of studies is to be conducted by a group of students (minimum of five students, but usually not more than twelve) comprising undergraduates or graduates, or an appropriate combination of the two.
* Projects proposed are to be student-originated, student-planned, and student-directed, and are to be carried out under the leadership of one of the students in the group.

- Support for projects will be provided by grants to 4-year colleges and universities that agree to serve as host and fiscal agent for the project.
- Projects are to occupy fully the time of the student investigators for an uninterrupted period of 10-12 weeks. This means that most projects will be conducted during the summer although projects may be conducted at other times in institutions with schedules that provide for 10 to 12 uninterrupted weeks for individual work or independent study during the academic year.
- Nominal stipends of up to $80 per week are provided. The proposers may also request funds to defray operating costs of the project, but the host institution is expected to contribute necessary facilities and use of permanent equipment.
- To request foundation support, student groups submit proposals that describe the scientific or technological studies they wish to carry out and that gives details as to the funds required for that purpose.
- Although the competition requires that proposals be developed by students, the Foundation encourages them to seek faculty and business office advice to meet needs which the students themselves perceive.

STATISTICAL PROFILE

	REQUESTS		AWARDS			
FY	PROPOSALS	DOLLARS (Millions)	GRANTS	PARTICIPANTS	DOLLARS (Millions)	INSTITUTIONS
1971	560	8.2	103	1,104	1.5	97
1972	282	4.3	134	1,340	1.9	120
1973	395	5.7	79	702	1.0	73
1974	266	3.5	135	1,190	1.7	115

INCREASING GAS SUPPLIES

Edwin F. Hardy, Associate Director
Planning Division, American Gas Association

BACKGROUND

Recent estimates show that U.S. gas consumption in 1973 was nearly 14 percent less than requirements that had been estimated in 1971. These shortages are the evidence of constantly increasing demands for gas and what now appears to be a plateau for natural gas production. The leveling out of production since 1970 contrasts sharply with the previous 15 years which saw a steady increase from 10 trillion cubic feet per year to 22 trillion for an average annual production increase of 5.25 percent per year. Although it is obvious that an annual gas production growth rate of this size could not continue indefinitely, there is no need for growth to cease now nor during the next decade or two. A healthy resource base is available and the technology required to harvest it can easily keep pace, if adequate financial incentives are available.

Just what are these so-called "adequate financial incentives?" In general terms, the major incentive is the price an exploration or production company expects will be received for any natural gas discovered. If the expected price is attractive engough, these people will do more U.S. drilling for gas and oil, and consequently more will be found and brought to market.

Why do we believe that more drilling will find more gas? Through 1973, the cumulative production of natural gas in the U.S. (since production first began) totalled about 460 trillion cubic feet. Since trillions are difficult to comprehend, just remember the 460. Also, at the end of 1973, the proved, or discovered, natural gas reserves of the U.S. were 250 trillion cubic feet. In addition, the undiscovered or potential gas supplies of the U.S. are estimated to be 1,146 trillion cubic feet. Other potential gas estimates are even larger than this one. Considering the 22.5 trillion cubic feet of gas we have been producing (or using), each year lately, we estimate that at least a 50-year supply is waiting to be found using conventional procedures. Improved discovery and production technology could increase this potential for the future even more.

Then why don't the natural gas production companies charge more for their product? In a free enterprise system, prices are supposed to keep supply and demand in balance. A shortage brings on higher prices which usually has the dual effect of reducing demands and increasing supplies. The problem with natural gas is that most of it has had federally controlled prices for many years. The federal control system does not recognize all of the economic forces at work in placing a value on natural gas and has kept ceiling prices in force which are artificially low. This has stimulated demand for cheap, clean gas while reducing gas well drilling efforts and the supplies more drilling would provide.

How low is this "artificially low" price range just mentioned? Some good indicators exist to compare with federally controlled gas prices. The current average wellhead price for interstate supplies of natural gas is about 26 cents per thousand cubic feet. This means one million BTU's of typical gas costs about

25¢, averaging all of the old and new contract prices, weighted by the volumes at these various prices. The average price of domestic crude oil is about $1.30 per million Btu's of heating value. Newly discovered U.S. crude oil sells for about $1.75 per million Btu's. Consequently, the average price of interstate gas is only 1/5 to 1/7 the price of crude oil for an equivalent amount of heat content.

Natural gas sales outside of interstate commerce, hence not subject to federal price control, are frequently made at prices 2 to 3 times larger than the average interstate price. The federal ceiling was recently raised to 43¢ per thousand cubic feet, but this is still an inadequate price for the interstate gas systems to compete effectively with the intrastate buyers for purchase of newly found gas supplies.

Our studies at A.G.A. indicate that gas production in the lower 48 states could continue to increase steadily through the 1980's, if stimulated by substantially higher prices. Moderate production increases can be achieved through the 1980's by immediate increase in field price for new interstate supplies up to the level of many current intrastate contracts. The $1.30 per mcf level of the highest intrastate price announced recently need not be reached until the mid-1980's. Higher prices would provide more significant production increases. Continuation of rigid, cost-based regulation of interstate gas field prices will result in steady production decreases, beginning immediately. We can see evidence of this pending supply decrease in this first slide (Slide I); which shows that, during the past six years, the new additions to proved gas reserves have been only half of our consumption and that production effectively stopped its long historical rise back in 1970.

GAS SUPPLIES AND DEMAND

The most important source of gas to the United States continues to be natural gas from the lower 48 states produced by conventional means. Future gas production will be more expensive but certainly will not push costs up to the estimated prices of the supplemental gas supplies now being developed.

The next slide (Slide 2-8) shows what can be expected between now and 1990 in natural gas volumes supplies from the 48 contiguous states. It indicates a current peak annual supply of marketable gas at about 18 trillion cubic feet. Note the demand curve which indicates what could be consumed, if supplies were available. One area in the lower 48 which could provide large quantities of gas in the shortest time (three to five years) is offshore in the Gulf of Mexico. The Gulf Coast is dominant among the few areas left in the United States today where the promise of discovery is high enough to draw a drilling crowd. That is, so long as large acreages of these lands are made available for leasing. Until recently, environmental concerns had effectively stopped exploration in this gas rich area, despite the universal acceptance of natural gas as today's prime fuel for air pollution control in the heavily populated areas of our nation. We now anxiously await the concrete results of the environmental hearings and study by the Council on Environmental Quality on offshore gas and oil operations and their effects upon the continental shelves of the U.S.

There has been evidence that Atlantic offshore drilling will be contested even more vigorously than the Gulf has been. The American Gas Association and others are involved in educational programs which are intended to help let the facts of offshore drilling and production be argued rather than depend wholly on emotions. I hope you have heard about our "Atlantic Action Program". If not, please let me know of your interest and I'll see that you get material on the program.

Turning our backs on future Atlantic offshore gas and oil supplies in favor of environmentally inferior energy alternatives, as argued by some parties today, could very well be the near term mistake impacting on the 1980's comparable to the way recent events have crippled the use of Gulf of Mexico gas supplies for the 1970's. We hope good national decisions can avoid such a serious delay in Atlantic development.

Several years ago, when early symptoms of a gas supply shortage were becoming apparent, natural gas transmission and distribution companies began a wide ranging search for ways to supplement their natural gas supplies. The lag times involved in changing governmental pricing policies and in fully developing the production capabilities of significant new reserves volumes, such as those available from the offshore and deeper reservoirs, will prevent a substantial increase in natural gas production for 5 years or more. Thus, the need for increased short-term supplies combined with the desire for positive self-help have lead to a variety of gas utility projects for supplemental supplies.

Supplemental gas supply projects are quite varied, most require large capital expenditures, and all provide gas which will cost significantly more than historical supplies. The programs involved vary widely in size and completion dates, in political and technical problems which must be solved, and in international aspects such as security of supply and balance of payments. However, as you will see, it is not a matter of choosing between the supplements for the optimum one or few to meet our gas demands--it is a case of pursuing all reasonable sources and still falling short of meeting demand growths as we have known them in recent years. I define supplemental sources of gas as ones which add to the total lower 48 states' supply.

Probably the quickest source of supplemental gas would be increased pipeline imports from the producing fields of western Canada. Canada added one trillion cubic feet to our domestic supplies in 1973. However, Canadian policy is to export only gas considered in excess of local needs, so it will take some large discoveries there, plus several years, for their commercial development to provide substantial additions to the United States system. In the late 1970's, we could be participating in the utilization of exciting gas discoveries being made in the Mackenzie River Delta and the island areas of Arctic Canada. United States gas companies and producing companies are investing hundreds of millions of dollars in the Canadian Arctic for the right to share in these discoveries. The first transport systems connecting these Arctic areas to the U.S. should be completed by 1979. This slide (Slide 2-8) illustrates a projection of Canada's contribution to our gas supply. By 1990, annual Canadian imports could reach three trillion cubic feet.

The second supplemental supply on my list is one which had the potential for supplying significant volumes of additional gas quickly and with low capital costs compared to the other supplements. I refer to the gasification of light hydro-carbons, such as naphtha and natural gas liquids to manufacture synthetic gas, or SNG. Governmental delays, first on import allocations for the liquid feedstocks for SNG plants has risen to the point where I predict that only a handful of plants will be built, utilizing feedstocks contracted for prior to today's higher oil prices. SNG volumes are expected to reach about one-half trillion cubic feet per year during 1975 and experience little or no growth thereafter. One year ago, we expected oil gasification to provide at least two trillion cubic feet per year by the late 1980's.

Next on the list of major supplemental gas supplies is imported liquefied natural gas (LNG) from numerous worldwide sources.

The most advanced major project for importing LNG is the one generated by El Paso Natural Gas which would move one billion cubic feet per day of natural gas equivalent in liquid state from Algeria to two terminals on the East Coast. Present schedules indicate this system will begin operation in 1977. Other gas utilities have announced serious planning of similar large projects for later dates involving imports from widespread points, such as Algeria, Russia, Australia, Indonesia, Alaska and Nigeria. Projected out to 1990, the LNG supplemental supply looks like this next slide (Slide 2-8), which shows a small beginning in 1975 and 3 trillion cubic feet per year by 1990.

LNG importations of the size being planned require import policy decisions which are slow in coming. The FPC has reacted favorably to LNG projects thus far, but no policy position has been issued from the Federal Energy Office.

The major long-range source of pipeline gas appears to be that which will be produced from coal. The United States has coal deposits which could meet current gas and coal demands for hundreds of years. The gas industry has been investing in coal gasification research for over 25 years and in 1971 agreed to an accelerated program, cooperating with the Department of Interior, which is spending $30 million a year on pilot plant development of several processes during a four year period. Commercial plants developed from this work should go on stream during the '80's. Each will produce about 250 million cubic feet per day from 25,000 tons of coal, which will cost approximately $500 million and employ about 1,000 people. It will take about 12 plants to produce one trillion cubic feet per year. Several coal gasification plants have been announced so far with startups scheduled for around 1978. These early plants will convert a subbituminous, non-caking coal using the old German-developed Lurgi process plus a new methanation process for increasing the Btu content of the product gas. Gas made from coal should total 2.8 trillion cubic feet per year by 1990 as indicated on this slide (Slide 2-8).

Farther downstream, we can look to Alaska for gas via a trans-Canadian pipeline or by trans-Alaskan gas pipeline to a Southern Alaska LNG plant where tankers would complete the trip to the West Coast. The major obstacle here has been environmental. Not necessarily resistance to a gas pipeline but delays in construction of the Alaskan oil pipeline. North Slope gas is associated with oil, and it cannot be recovered until the oil is produced. Now that the oil pipeline can be built, it appears that North Slope gas could be moving to the lower 48 states by 1979. Recent estimates indicate a 48 inch pipeline capable of moving over 4 billion cubic feet per day of Arctic gas 2,500 miles to the Great Lakes area border of the United States will cost about $5.7 billion. El Paso Natural Gas, which is studying the Alaskan LNG project mentioned, estimates their gas pipeline and LNG project will cost about $3.5 billion to move 1.5 billion cubic feet per day. The next slide (Slide 2-8) shows current estimates of Alaskan gas moving into the lower 48 states.

By 1980, advanced fracturing techniques should have been developed and implemented to release natural gas from the low permeability reservoirs of several Rocky Mountain geologic basins. Applied research work on nuclear fracturing and recently planned massive hydraulic fracturing experiments are expected to initiate small volumes of production from these tight rocks beginning in 1977--expanding to about 1.5 trillion cubic feet per year by 1990.

Review of this set of fairly optimistic forecasts shows that total gas supply growth becomes equal to demand growth between 1980 and 1990, due primarily to rapid buildups in supplemental gas availability. However, total supplies remain about 4 trillion cubic feet (Tr cf) per year below total demands. The total supplemental gas supply thus projected is 13.4 Tr cf in 1990 or about 40% of the 32.4 Tr cf total U.S. supply available for sale. Please consider that it will take many coordinated, positive actions by the governmental agencies involved in energy policy and control decisions, and continued innovation and huge capital investments by the natural gas industry to meet this set of supply projections. Poor performance by either government or industry could worsen the picture. Supply volumes greater than these projections could be developed by some major technology advancements or significant improvements in the economics which motivate gas exploration.

HYDROGEN

At some point in time, whether it is 50 years, 100 years, or longer, the U.S. natural gas resource will be depleted. Liquid petroleum supplies may be gone sooner. Even coal resources have a finite limit. Most people expect nuclear generated electricity to fill large parts of the supply voids left as fossil fuels approach exhaustion. Solar energy probably will play an important role as well--through direct conversion processes and through the indirect biomass conversion process.

An interesting switch in primary and secondary energy sources may occur as we progress well into the nuclear power era. Today we think of electricity as a secondary source of energy because most of it is generated by burning a primary fuel--gas, oil or coal. Hydrogen may become a secondary energy source generated by nuclear power--probably from water through either electrolysis, thermal cracking or chemical separation of water.

Why would hydrogen have a place in the so-called "all-electric economy?" Hydrogen has economic and environmental advantages over electricity in several parts of an energy system. Large scale storage of electricity is impractical and considerably more expensive than either underground storage or cryogenic liquid storage of hydrogen. Hydrogen transmissiom through underground piping would be less expensive, more efficient and more environmentally acceptable than overhead electric cables. Since electricity is not portable, it is not well suited to transportation needs of vehicles and aircraft. Hydrogen may be ideal for advanced aircraft fuel systems, as it has been for rocket engine fuel.

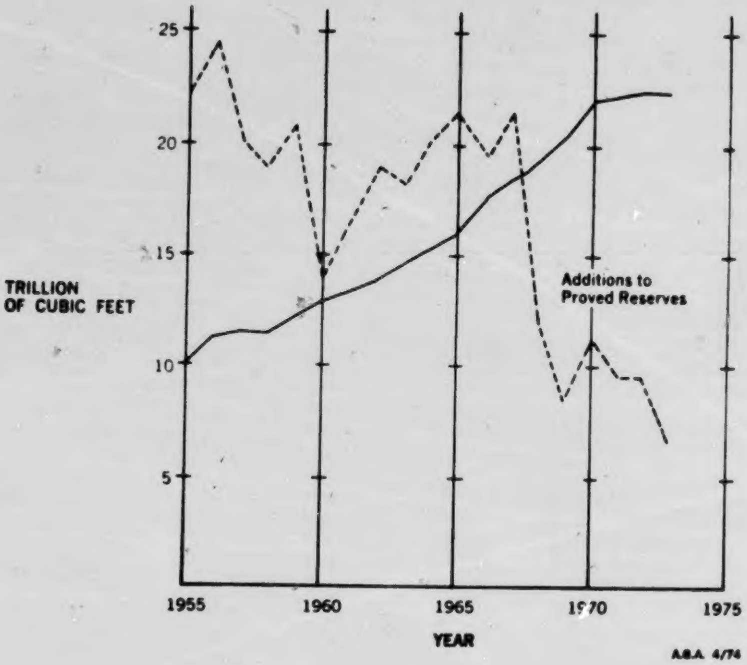
Hydrogen also is considered to be the ideal fuel for the environment, since the only significant product of combustion is water. Burned catalytically at low temperatures, not even nitrogen oxides are formed.

Much work has to be done to develop the "hydrogen economy". But we still do not have the breeder nor fusion economy either, do we?

There is much more to say about the future of natural gas, substitute gases and the possibilities of a hydrogen economy with its local fuel cells to generate the 10% of our energy which must be electricity, but time will not permit my continuing. I understand we have time for questions now, and hopefully some answers too.

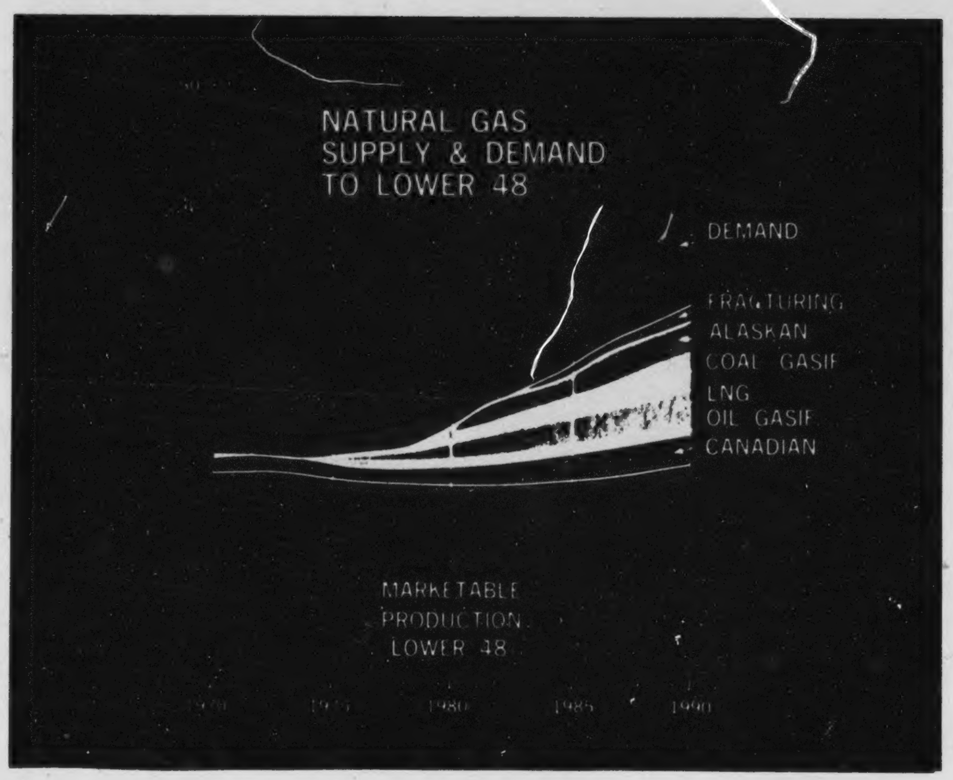
Slide 1

ANNUAL PRODUCTION VS. ANNUAL ADDITIONS TO RESERVES—LOWER 48 STATES



A.B.A. 4/74

Slide 2-8



NATURAL GAS
SUPPLY & DEMAND
TO LOWER 48

QUESTION AND ANSWER SESSION

"Increasing Gas Supplies"

Speaker: Edwin F. Hardy

DELEGATE: What non-power uses does natural gas have? Is it used in any chemical by-product industries at all?

HARDY: It's used as fuel very heavily in industry and provides about 45% of fuel in the industrial sector.

DELEGATE: I meant in terms of producing chemicals for non-energy.

HARDY: Fertilizers are a large use.

DELEGATE: Does the American Gas Association sponsor any projects in electrolysis as in the production of hydrogen as an energy source?

HARDY: The Institute of Gas Technology (IGT) is doing some work on the "Hydrogen Economy", but I'm not aware that they're doing electrolysis work. IGT may be-- I'm just not aware of it. I believe you did get a copy of our research book which is a long range research plan that AGA has developed.

DELEGATE: I wanted to know whether your association has thought of using gasification of oil shale. I know they use it in Russia extensively because they heat the cities of Tallin and Leningrad exclusively with synthetic gas that they make from oil shale.

HARDY: We have thought about it, and we have long range research plans for not only shale, but using other heavy oils as well.

DELEGATE: One question is what do you feel the impact will be and why do you feel that way on the removal of the gas and oil depletion allowance?

HARDY: This country jerks itself around in two directions. Right now, we're interested in energy independence which means we've got to do something to stimulate our own energy production. At the same time, we've got other people in government who talk about taking away the oil depletion allowance, which is a major incentive now. Certainly, if you do take away the depletion allowance, increased taxes will be passed on to consumers. Here again, the Shell Oil Company representative could probably talk more intelligently on this than I can because he is closer to it. We at AGA do not represent the production side of the industry that benefits from the depletion allowance.

There are figures available on how much more the consumer would have to pay for his oil products if you take away the depletion allowance. The companies are going to cover their costs and make a profit or they are going to go out of business. If you don't get it through the depletion allowance then you spread the cost another way.

DELEGATE: I would also like to know what the environmental considerations are of Liquified Natural Gas (LNG) plants?

HARDY: LNG plants? To me, they're minor. Consider the plant at Cove Point, Maryland, which is where the El Paso Number One Project will have a terminal; a very large project. The main problem there, I believe, was an invasion of some wet lands. It did place a pier well out into a bay area, and encroached on an area the state had planned to use at some point. I never really understood all the problems. They reached compromises instead of building a pier out to where the water depth would handle the cryogenic tankers. A tunnel will be constructed between the shore and an offshore docking facility.

DELEGATE: If Nixon were to release impounded funds for sewage treatment plant construction, do you think that Methane CH_4 production from such plants could make a significant contribution to the U.S. gas supply?

HARDY: No.

DELEGATE: What type of contribution do you think it could make?

HARDY: I don't have a number, but sewage is a small part of the total available energy in waste solids. Taking all the waste solids that are in urban areas, where the concentration is up enough to make it attractive enough for anybody to try, it's still a pretty small percentage of the energy required by that area.

DELEGATE: What do you mean by a small percentage? Do you have an idea of how many sewage treatment plants are to be built in the U.S. if the new public law 92500 grant goes into effect?

HARDY: No, I sure don't.

DELEGATE: I think someone needs to know, wouldn't you say? There are a lot of small sources of energy available that people say, "Well, that's not significant, and this one's not significant." But I think many of the small sources added up together could make a contribution.

HARDY: Well, I'm not saying that they won't be made use of; I just don't think it will be very significant. It may be done. To go back to the next to the last question you had: I believe the number is somewhere between five and ten percent of the natural gas that's normally consumed in an urban area could be provided by solid waste conversion to gas. This is being done, and it's got some attractive parts to it. For instance, you get an operating credit from the fact that garbage is being collected and transported already--you don't have that as a new cost.

WALT KRESS (Shell Oil Company): One of the more interesting things that was written up lately is that some farmer developed a system for using manure from the farm, and all he did was take several steel drums and made a fermenting tank and a gas collector, and the numbers I saw recently said this is something like a three thousand acre farm, and I don't know how many cows he had--but he had made enough gas he claims to completely heat his house in the winter time, to heat his barns, and he's compressing some of it and using it as a fuel in his tractors and his automobiles. He claims that he's almost self-sufficient on energy. How true all this is, I don't know, but it's an interesting development, and I understand it's spreading like wildfire.

DELEGATE: I believe the approximate figures for the gas was 100% efficiency that could be yielded from all sewage sources, that is, agricultural and municipal in this country. However, you cannot get anywhere near that good recovery--alot of it just sits on the fields, so it can't be used. Also, it does take some energy to run the divestors, but you might possibly get something like 20% in the reasonably near future.

FRADIN (FASST): The figure on the energy from the waste from cities' supplies is given at somewhere between nine and thirteen percent of the energy of the city.

DELEGATE: They probably also use solid waste paper.

FRADIN: Paper's the majority of it.

HARDY: One of the newest trials of this kind is sinking shallow wells into land fills--garbage land fills--and recovering low BTU gas--but it burns. If you've got an old land fill in your backyard and want to invest your money and capture some of that gas and use it to heat your house--that's fine. I think a lot of this small-sclae type thing will be helpful, but on the scale of what we're talking about, it isn't a very significant contribution. An awful lot of these theoretical small sources would be costly to develop. You could become so spread out that you may be paying a hundred dollars for some of this kind of gas. Certainly, you're up in the many dollars per thousand cubic feet range, whereas we are paying 25¢ in the gas fields now.

DELEGATE: Would you comment on the implications of the natural gas shortfall which you have projected for the next few years. Noting that the Arab oil boycott involved only a 4% shortfall, do you think that the situation could reach crisis proportions?

HARDY: Well, what I showed up here (see slide 2-8) is one set of possible supply projections. This was far from the lower forty-eight state production figure which I believe showed is achievable. The curve had a small saddle in it and ended up at about the same volume of production out in 1990 as we have now. That is what a lot of people are projecting will happen, if we continue to believe that gas is a "no-growth" source of energy for the U.S. The Federal Energy Administration (FEA) has decided that gas production is something we cannot increase--that if we do a lot of drilling we can count on staying even. The FEA says we can't do any better than that. I don't believe this, but that's what they're saying. This chart (see slide 2-8) I have is showing a shortage. By 1985, we've got a shortage of 12 trillion cubic feet. In another case (in this case we talk about new gas being priced at 90¢ next year and going up from that) we've got a shortage of only 2 trillion cubic feet by 1985.

DELEGATE: What in effect is going to make up those shortages? Are people going to be able to convert to oil in the next few years? Clearly, something has to give.

HARDY: Either use something else, or that is a demand that won't be satisfied.

DELEGATE: Don't you anticipate that reaching crisis proportions?

HARDY: Well, I think that there's a potential for crisis there, yes.

DELEGATE: Along this same line, because of the recent environmental pressures there's been a lot of pressure for companies to switch from coal to natural gas, and then last winter especially during the gas shortages there was a lot of pressure because of the shortage of gas to switch back to coal. I haven't read any figures on just how many companies were switching from coal to gas, and because of the pressures of the gas shortage how many of them switched from gas back to coal? Could you comment on this?

HARDY: I can't give you the hard numbers. I know the switches were not just between coal and gas, but between coal and oil as well. Were you going to talk about plant conversions? I feel terribly unprepared. The switch to use of gas for generating electricity stopped--oh, about two years ago and now it's declining. The primary reason why the use of gas for generating electricity is declining is because an awful lot of that load was sold under what we call "interruptible contracts", and they're being interrupted very heavily.

In addition to that, when we look at demand, a tremendous number of contracts that are written for gas (these are normally twenty-year contracts) have growth clauses in them. The buyer is expected to buy more gas each year and the supplier agrees to supply more gas each year. The bulk of the gas curtailments that occur are either in interruptible contracts being denied, being interrupted or growth is being denied. There are a few instances where you have a gas transmission or distribution company which actually gets less gas per year than it did last year or the year before. And, of course, that's reasonable because production really hasn't started to turn down yet. We're producing the same amount and we aren't wasting as much, so there's no real reason for anybody (except we always have local inconsistencies, of course) to fear loss of residential requirements. Some companies are not experiencing any curtailment of firm contracts, others are.

DELEGATE: You just spoke on the growth aspect of gas. An average small homeowner, then, who is planning on building a new home, say or someone who is building a sub-division; they're planning to use only gas in their houses or else use electricity. How is this going to affect energy supplies in the future? Is there a tendency now towards more electric homes rather than gas homes? If a person does build a gas home, then what guarantees does he have that there will be a gas supply in the future to supply his home?

HARDY: I think that [because of what we show here] even if we only get half of the supplemental supplies that I've projected here, there still can be supply growth. Motherhood and the Federal Power Commission both say that the residential user will get his gas whether anybody else does or not. So, I don't think the homeowner has to worry about his gas supply. The total consumption of residential gas is much less than half of the gas consumed. We're no where near having only half of our past gas. I don't even project that up through the year 2000.

DELEGATE: So, you don't see any problem in the foreseeable future, then, with the homeowner who uses gas?

HARDY: The problem he's got is like where I live (in the Washington, D. C. area) where if you want to use gas in your new home, you just can't get it. They won't sell it to you. They have a moratorium on new hook-ups.

DELEGATE: In the West where I'm from (Utah) that problem doesn't exist at the present time because we still have large gas supplies out there.

HARDY: Other parts of the country are just like that. Surprisingly, though, Texas and Louisiana are two areas where it's very difficult to get gas.

FOSSIL FUELS AND FUTURE SOCIETY

Walter E. Kress, East Coast Representative,
Public Affairs Organization (Environmental Conservation Department),
Shell Oil Company

I am glad to be here and when David (Fradin) and Roger (Guisinger) invited me to come I welcomed the opportunity. I really like to talk to college people as it makes me feel a little bit young again.

First, I would like to tell you who I am because I think that is something you should learn. You have to learn who is talking to you. That is very important because you may get a lot of information, and it may be pretty much out of thin air. I hope mine isn't.

I'm a chemical engineer by formal training and have been with Shell Oil Company for thirty-two years. That is a pretty short time actually. Most of my career has been spent in manufacturing, making gasoline, fuel oils, jet fuels, working in research; I've also done some patent work. I guess everybody in my family goes to school. My daughter goes to school, her husband goes to school, and my wife goes to school, so we are pretty well school-oriented at my house. The bill is pretty big too--but that's a good way to spend money.

The thing I want to talk about today is what I hope will fulfill some of the objectives that Dave and Roger have written down. I will try to summarize the things that I am interested in, in that area: "To enable student participants to communicate with industry and government representatives."

Communication is kind of a magic word now in society. We have got to communicate and understand. A lot of things that go wrong between industry and government, for instance, can often be attributed simply to a lack of communication. People don't understand each other. I hope today that not only will I be able to give you some kind of information that you will find of value to you, but I hope for even better communications in the discussion and the questions and answers.

I worked in manufacturing for most of my career, I have also been an advisor to a vice-president--all this kind of thing that goes along with being a technical man. Three years ago, I ran into a health problem, and I couldn't work anymore in refineries nor accept a transfer to Houston. I had to stay in the New York area. The company said we don't want to lose you, we would like to keep you--you have had a lot of experience. We think you would be an asset in our Public Affairs Department. As a matter of fact, the last three years probably have been the happiest of my career. I'm not going to tell you today how we made gasoline, that you can learn in school out of a textbook. As I said before, I think the most important part of my participation is answering, or hoping to answer your questions.

Energy is getting a lot more attention today than in other years. There have been other periods in our history where there have been similar crises--you know wood used to be the primary source of energy up until about 1825. Then they switched over to coal. And then with the advent of the discovery of oil and gas, the energy people pretty much switched over to using oil and gas. I guess the primary question is why so much interest in energy. I guess it's all pretty obvious. Energy is sort of the life-blood of our system. I don't know how many studies and correlations I've seen that illustrate the growth in gross national product with energy usage. It's a one-to-one correlation, almost a perfect correlation. You can plot the gross national product in the United States over a period of time versus energy, and it is a nice straight line. A little wiggles in it, but statistically very significant. The other way to look at it is on a worldwide basis, and you can see the relationship between a country's gross national product and its consumption of energy. There are some efficiency factors in here, but again it is a pretty straight line. There are discussions on this because it relates to population growth and other things. But the primary factor seems to be using energy to produce material wealth.

A great number of things that we have in this country can be attributed to the use of energy. It is the people using energy who have permitted us to make such a fantastic growth. And that, of course, brings you to the social problem. Growth today is being discussed very widely with the population now at 3 1/2 to 4 billion people in the world. In the next fifteen years, it is expected to go to 7 billion. It is of great concern that we are using our resources much faster than we are replacing them through technological effort. If you have read the Club of Rome Study, the so-called "Limits to Growth," there is a lot of concern that we are using our raw materials at an alarming rate. As a matter of fact, in this country when you talk about energy, we have 6 percent of the world's population, and we are using well over 30 percent of the world's energy. That is a big ratio. If the rest of the world had been using energy at our rate, and we hadn't had any new developments, we would probably be out of energy right now. It is a problem.

The Limited Growth Study that the Massachusetts Institute of Technology did, a computer study, is a model approach. They built a model of the world. This took into account the population, the pollution rate, the growth and production rate and the use of various raw materials. Out of this computer program with different premises, if we continue to grow at this rate, and continue to use this kind of material at another rate, and you put that all together in a package and you follow it for about 100 years, you get strange answers.

My grandchildren may not be able to use copper 40 or 50 years from now. Zinc is rapidly disappearing. This all relates to known reserves. But even when they look at five times the known reserves, they still run out because of the tremendous growth in demand, so instead of running out in thirty years, they run out in forty years.

But then there are a lot of factors they haven't taken into account, recycling for instance. Presumably if this is a spaceship that we are on and you have x number of tons of copper, you know you can almost continually use it. You don't throw it away. You put it back into the system. This is not as cheap as using something that you dig out of the ground, however.

Now, I am supposed to talk about oil and gas and I haven't really talked about it yet. But, oil and gas, of course, are major parts of our energy supply. And you can't divorce oil and gas because when you go out and find an oil well, you usually find gas. The percentage of the total domestic gas production, which comes from concurrent finding of oil is about 30 percent. And as a matter of fact, about 75 percent of the total energy that we use in this country is oil and gas. The other 25 percent is mostly coal, a percent or 2 is nuclear, and some is hydropower. And then these other things you were talking about; there is a a trickle of solar power, a trickle of geothermal, and there is tidal power being looked at. There are many sources of energy, but primarily we have used oil and gas, and I'm sure this is pretty obvious.

Those of you who are in engineering will know that the easiest way to handle material is in a liquid form. Crude oil is great. I think the American automobile, as we know it, has developed primarily due to the availability of gasoline. You can carry enough around in a nominal sized tank to permit you to drive 300 miles on one filling. You can't do that with gas. This hydrogen economy that we talk about is very tenuous. It's hard to store enough hydrogen in an automobile to permit you to go more than maybe 100 miles. So liquids are great. We handle them in pipelines. Pipelines are definitely the cheapest way of distributing things, and distribution is a major factor in our industry. Our industry is partly manufacturing but the major part is distribution.

Let me show you a little bit about what we have been doing in our company. Remember a major oil company has a big responsibility. We have to do things at the right time so that we will have available for public use the things that they want; in our particular case, gasoline, jet fuel, fuel oil, etc. So, for a good number of years, we have had a planning group in our company that tries to look ahead and say what the demand for oil is going to be, how it is going to be met, and what our part will be in it. The first thing we have to do is understand what is going on in the world, then we will understand how we fit into it.

I thought I would just quickly go over one of our forecasts to show you the kinds of things that someday you'll be doing. The most obvious variable that you have to deal with when you talk about the future is what is going to happen to population. There are a lot of forecasts on population, but after our experts looked at it, they picked this forecast from the Government (Series E Projection) which is a one percent average annual growth. We have to also assume, of course, that there will be no major changes in our lifestyles--that we will continue to drive cars, fly jet planes and this sort of thing--that there will be no significant change in the political system or taxation policy, and of course, what this relates to is the fact that we are part of a great economy: the private enterprise system. And if the system along with the rules are stable and steady, then you can plan. The things that disturbs industry more than anything else is when the rule keeps changing.

You have to paint a picture of a Board of Directors meeting. I have been on a crew of people that have worked on investment. We go to the Board of Directors and say we would like to build a refinery in this location that is going to cost 300 million dollars, and you are going to get a rate of return of eight percent. Now they have the responsibility of saying "yes or no," because it is the company's money we are going to spend and they are responsible for it. So, they start asking us questions, "What tax rate does it use?" We say, "We use the present rate." They say, "Are you sure that is going to be the rate over the next twenty years?" So, we tell them what we can about the past, and how we think that will extrapolate the future. We have to assume that the free enterprise system is going to work. That the capital investment process is going to create all of these things that we need.

We had been asking for a long time, and we think we are getting closer to a national energy policy (this gets back to things that you were asking before about what is natural gas going to be used for). We think that in the long run, the Government is going to have to make some rules and say natural gas is the best kind of fuel for the home consumer, so it would primarily go to homes. Anything left over might go to some kind of industry that can't very well convert to oil, or nuclear, or electricity, or whatever it may be. So we think that there should be a policy. We think this policy will pave the development of domestic resources and this gets back to Project Independence.

Everybody wants to make us free from the rest of the world's political problems. Not everybody feels that is a very good idea. Some feel that we should maintain some flexibility--go in the direction of being pretty well secure domestically, but we don't think we should just build a fence around the United States and forget about everything else. We think we are involved and that there should be a give and take, and we think this will be better for the future of the world.

Of course, the environmental problem is a big problem, and that does interfere with getting the job done. But maybe it has to be done. We think that eventually there will be a national land use policy. The State of New Jersey, for instance, is one of the most densely populated political entities in the entire world. As a country or state, it has more people per acre than Holland or Belgium which we usually think of as being very crowded. And that is going to happen more and more. They're arguing about this in the legislative halls right now.

Somebody mentioned this morning that in order to get going in the gas business, you have to let the price rise to meet the market price. I'm sure you all know that when prices go up the guys with the money say there is a good place to invest money. If you keep the price of natural gas way down, there are going to be less guys interested in drilling for natural gas.

We've got to conserve energy, and, of course, that relates to the efficient use of energy. Even though we don't want to be completely independent, we think we have to pretty much make ourselves, so that when things do happen in the world, we can jump into the crunch and handle the situation. Economics is a real problem. A big thing that is going on is this inflation which is driving everybody mad. For instance, the oil companies presumably made a lot of profits in the last six or eight months. Unfortunately, the dollars we are getting in now are worth a lot less than the dollars we spent when we built our facilities.

We build a refinery in 1965 that cost us about 250 million dollars but it was in 1965 dollars. Now we are getting a lot of dollars back but they are in 1974 dollars. And you can't buy as many loaves of bread with the 1974 dollar as you could with the 1965 dollar. If you use the discounted cash flow, and you take inflation into account, instead of making what we think is a nine or ten percent return on our money, it looks like on a constant dollar basis, we are only making four or five percent. Now we don't noise that figure around to the Board of Directors very much because they get upset, but on the other hand, they do want to know what is going on.

There is a lot of technological effort that is going to be required, mostly because of the environment, and we think one of the big sticks in all of this is stack gas scrubbing to handle high sulphur fuels. We think that we'll be commercial in the next couple of years. In fact, we think we have a process of our own that is pretty good. And that process will permit us to burn high sulphur coal and high sulphur oils. The big push for natural gas, of course, is that it is a very clean fuel, very easy to handle, and the price is low.

I said before that one of the reasons we are interested in population is that although right now population seems to be leveling off, particularly in the United States, it is not really growing too fast. We now have a slow growth. But the thing that is really happening is that the twenty year olds to age thirty are the big consuming market in this country. That's where all the new drivers come from. It is a very high percentage of the population because of the baby boom of the late 40's. Those are the people that consume a lot of energy in this country. We think our total market demand is going to grow from the rate we are now at, which is in the 30 million barrels a day range, to a total energy demand of about 68 million barrels per day by 1990.

Transportation is the big area of increase--two and three car families, everybody's running around, flying around. Airports are overloaded. Residentials are increasing as is industrial, but most of it's in transportation. The other thing is the fantastic growth of chemical manufacturing feedstocks. That's because--well, look around the room: the tremendous amounts of plastic.

We forecast that as far as supply goes, oil is going to continue to get its share of the market. Gas, I think, as Ed showed, is going to be leveling off. We're kind of running out of gas. Coal pretty soon is going to be the predominant source of energy that we have in this country. Sometime later in this de-

43

cade, we can see nuclear as really accelerating as an energy supply when all the problems of construction and environment are taken care of.

[97 feet of tape untranscribable here]

I promised to talk a little bit about the environment. The environment is a social problem, really. Those of us who have been traveling to Los Angeles over the past twenty years should understand. When you fly into Los Angeles, you fly into a bowl of soup. There has been a lot of effort on the part of the public, the Government, and industry, to stop this pollution. Unfortunately, you don't "do this for nothing" and it means that you have to make up your mind that you are going to divert money from the system--such as for smaller cars--because we have got to put money into environmental control.

I think the primary question is how much environmental control do we need? On water discharge permits, for instance, we have a product terminal in New Jersey and the Federal Environmental Protection Agency (EPA) just gave us a permit for our waste water effluence which flows into Arthur Hill--that's the stream between Staten Island and New Jersey. The permit limits us to one part per million of oil and grease in the waste water. The big argument there is: Can it be reliably measured? There is considerable doubt as to how to measure one part per million (not really, it can be done, but it is a difficult procedure). But then after you know how to measure it, to put in the facilities to clean up any effluents down to one part per million is a very difficult thing. It takes a lot of technological effort. It probably can be done, but it is going to cost a lot of money.

On air pollution, we have been building hydrotreaters now for a number of years to hydro-treat all fuel so it gets the sulphur out. Of course, you know all about transportation control strategy plans that the Federal EPA has been promoting and what that says is that in some cities people are going to have to stop driving downtown. They can't stand the carbon monoxide. Of course, a lot of people object to that. They want the freedom of driving their automobiles. So, one way that is going to be gotten around is the catalytic converter which takes the exhaust of the automobile and burns up the CO to CO_2, which is relatively innocuous.

If there are any questions, let's stop here and answer them.

PANEL DISCUSSION
"OIL AND NATURAL GAS SUPPLIES"

Panel Members: Edwin F. Hardy, Associate Director, Planning Division
American Gas Association; and
Walter E. Kress, East Coast Representative,
Public Affairs Organization (Environmental Conservation Department),
Shell Oil Company

DELEGATE: I've seen a lot of predictions on where our gas supplies are and many of them show that most of the potential supplies of the world are in the U. S. area--I'm talking about the coast of Alaska, the West coast, and in the Gulf of Mexico. Does the American Gas Association (AGA) have predictions similar to this?

HARDY: The AGA doesn't make geological-type surveys. We help sponsor this type of work. We throw money in the pot with other organizations so that it can be done. The Colorado School of Mines provides the potential gas estimate, the Potential Gas Agency out there does it. They use industry people who are familiar with the geologic basins of the U.S. to put together these gas estimates. These are beyond the proven reserve numbers. There are other organizations, of course, around the world who do it for different parts of the world. Russia has tremendous gas volumes. Algeria is no slouch.

KRESS: King Hubbard's book is probably the best book on the subject. What he did was, he said, the earth has got a thin film around it, and he's taken out the deep areas and all that sort of stuff; and winds up saying, "Look, there's only this possibility. That is it." It's a blip on the curve. Take four million years of mankind; we are just a little speck there; and our oil's going to go up and right down, according to King Hubbard.

DELEGATE: O.K. Mr. Hardy, is it a lack of money or is it the slowing up in leasing like government offshore leasing programs--is that what's slowing up the exploration?

HARDY: What has slowed it up is not just pricing. We're now approaching, I guess, the offshore leasing goal that President Nixon stated back in April of 1973 of 3 million acres per year. He's also since talked about ten million acres per year. I think that's a rediculously high number. We'll be hard-pressed to take full advantage of 3 million acres a year. It'll take a lot of effort to get the amount of drilling per acre done on three million acres per year that we have in the past and recently experienced when we had less than one million acres per year to drill up. There are other bottlenecks. If suddenly the price bottleneck to drilling would go away, the next bottleneck would probably be either crew or drilling availability.

Right now we've about 1,400 active drilling rigs in the U.S. To get the needed drilling activity, we need to build up as rapidly as we can to about 3,000. We need 16 hundred more rigs in the U.S. There are people who say that we can get those by 1980 or a little sooner. This kind of build-up means doubling the number. This is one of the things I was talking about where you need an incentive that you think is going to last. The Federal Power Commission (FPC) has lowered the allowable price of gas even after contracts have been written.

45

There's that kind of history staring at people. So, just because we have suddenly gotten 43¢, it doesn't make people think we're going to keep 43¢. There are still people saying "Well, I wonder when it'll go back to 26¢ again."

The next Administration will have to start putting in a new commission (FPC). It may turn right around and move field prices back down again. So, even when these incentives are right (including this last one, that's beyond price--the so-called sanctity of contract), other bottlenecks will show up.

DELEGATE: Something else on liquid natural gas, of course, is it's really expensive to freeze natural gas and bring it across an ocean in specially built ships. Have you given any consideration to something like building plants in foreign countries to convert methane to methyl alcohol, bring it over, re-convert it to methane and use it? Is work starting to be done on that?

HARDY: Commercial projects have been announced and some have folded. One live one that still exists is Houston Natural Gas working with Saudia Arabia. The problem with methanol is the conversion process in the location where you have the inexpensive natural gas--most in the Persian Gulf is wasted. The capital expense is very high for the facility to make the methanol--considerably higher than the refrigeration plant to make LNG. However, the transportation costs for methonal in standard clean tankers is much less than for LNG in cryogenic tankers. So there's a cross-over point--methanol is more expensive than LNG for short distances. There are a lot of other variables, but the Persian Gulf at twelve thousand miles is obviously a methanol area. North Africa where you're talking more like three thousand miles is obviously an LNG source. Possibly the technology for methanol production will make price reductions that will shorten that distance at which they will break even.

DELEGATE: What is now the price for producing synthetic gas? Is there a figure on that yet, or is it too soon to tell?

HARDY: There are many figures. The price of plants is going up so fast and it is a capital intensive business. There are prices as low as a dollar and you'll see others at a dollar-and-a-half. It's funny, LNG and all these supplements may end up costing about the same. Two years ago, when it looked like El Paso was going to bring LNG into Cove Point, Maryland for 77 cents, people were screaming bloody murder about it. The Federal Power Commission says well, you'll not fold it into regular supplies and average the price and sell it to people that way. You will sell it incrementally. You'll have to find people who will buy it for 77 cents plus re-gasification and transportation charges. I guess it's the District Court that has now said the FPC didn't explain itself well enough so they are going back to rule on this again. But, all of a sudden, with oil at a $1.75 per million BTU's makes this LNG at 77 cents look awfully good.

DELEGATE: One question for Mr. Kress--Most of the companies around the country have been really holding back on starting a refinery or even holding up production like building super-tankers. Won't it get to a point that, if we do get the oil, we won't have any way to get it over because it takes two or three years?

KRESS: Yes, I had a chart here which shows where we reached limits on refining capacity. There's an awful lot of movement right now because of price. There's been at least three new refineries announced in the Louisiana area, and we're still looking. As soon as we feel a little more secure about our supply of crude oil, we'll probably go ahead with our New Jersey plant, as soon as we can satisfy the environmental problems. Of course, there's several possibilities in New England that people are just itching to get in there and build refineries. The political authorities want it. It's a source of income, and I think it's going to work. But, you're right there's a transition here where things are going to be a little tight and it's going to take some planning and that's why the actions of the Federal Government are needed. This is a national problem. It's no a state or a city problem, but a national problem. We need leadership in this area. Business people want some stability; they want to know what's going to happen down the road. If everything is bouncing all over the place, they are very reluctant to throw their capital in. Our company every year has to spend so much capital. They've got it. They want to do something. We've been building chemical plants like mad. In fact, well over 10 percent of our business now is in chemicals. We're building another plant in our system--230 million dollars or some number like that.

HARDY: Mr. Chairman, could I ask a question? This is a little bit involved, but it's an economic question. Turn our situations around and let me ask you all a question. Visualize yourselves as the Federal Power Commission and you're making the economic decisions. You've got a gas company, say El Paso, coming in and saying, "We're going after our second project on LNG. The price is going up considerably. Algeria has found out what their natural gas is worth, and instead of 77¢ now we're going to bring it in at $1.50." Now these are fictitious numbers; I don't know what they will be. But the next project is going to come in at $1.50. Now this is $1.50 up in the Chesapeake Bay. You can re-gasify that and move it to New York City, maybe at about $1.60. Of course, you don't have to take it to NYC, you can use it in Baltimore or Washington or Philadelphia. But just say it gets to the city gate of a distribution company for about $1.60.

All right, you can take U.S. gas from the Southwest and let's say that's up to 30¢ by the same time frame. It costs 2¢ per hundred miles to move it, so to get it up into the same area, you're talking about another 20¢. So we've got a city gate price for U.S. natural gas at Washington, D. C. of 50¢. You've got the other gas coming in at $1.50, but you don't have any more U.S. gas coming; whatever you're getting into Washington from the Southwest is all you're going to get for awhile. This is what the FPC has to consider now. It has kept the price of U.S. natural gas production where it is. They're refusing to allow people to pay 55¢ for gas everyday because that's too much. On the other hand now, they've got a project to add an additional increment of energy to the U.S. but at $1.50 per million BTU's.

Something that they very rarely are allowed to look at, or they don't allow themselves to look at, is what would any other increment of energy to the U.S. cost? And, let's just say that you can find crude at ten dollars a barrel. Well, that's a dollar seventy-five for the same million BTU's we're talking about. What are you going to do? Are you going to allow this company to bring in this gas for $1.50 and sell it for a $1.60 and yesterday you just got through telling some company they absolutely could not buy some gas out of Louisiana for 55¢ because that's too much? That's the kind of dilemma that people in authority have: What's best for the country? What should you do?

DELEGATE: Well, there's the problem of inflation and also there's the problem of income dislocations, but the government could worry about that in another way by some kind of transfer payments or something, but if people are willing to pay that amount of money to get that gas, I can't see why the government would refuse to allow that.

KRESS: You've got the same positional scenario. You've got a congressman and his home district uses gas. They don't produce any; they just use it. That's true of the majority of Congressmen. So he let's the price go up to meet market prices. So he let's the price go up to meet market prices. So, what happens? He's out of a job at the next election because they're going to say "Look, you are the guy that let the price of our gas jump up to $2.00 a million BTU's." So he has a political problem to solve. Can he vote for letting the price of natural gas go to market value and still keep his job?

HARDY: A lot of people have a little problem when you start talking about de-regulation, several problems. First of all, when AGA talks about de-regulation (and the American Gas Association--even though it doesn't represent the producers--is in favor of de-regulation of new supplies, not gas that's already under contract). This is an incentive to go out and discover. We're only talking about the de-regulation of the well-head price. This is the price that the producer receives when he sells gas to the people that we represent. The transmis-

47

sion companies and the distribution companies are natural monopolies. They need to be regulated. They are regulated, and we are not in favor of their de-regulation. You can't be--they are utilities. We're only talking about de-regulation of producer sales.

DELEGATE: What about TERA (AGA's energy model: Total Energy Resource Analysis) and decision-making policies, TERA accuracy and TERA's future?

HARDY: We hope that we can run that through TERA for them. You'd be surprised. TERA has been operational since the first of the year. AGA represents 300 gas companies scattered all over the country including Hawaii and Alaska. Trying to get this many executives to agree on when TERA is ready is a real problem. We are about home now. I have a paper being published on the supply model part of it in October for the Society of Petroleum Engineers, because it is modeling the exploration production phase of the industry for gas and oil. It includes gas and oil because the calculated profitability is from both. We hope to be able to use it--that's our primary concern for developing the model. It is far and away the most comprehensive natural gas supply model that exists. The FEA has just recently brought it to work into their overall energy model for the nation. It will be the gas portion. It's being expanded into coal and oil. But developing answers to policy options is what we developed it for.

DELEGATE: Do you know how accurate the model is now?

HARDY: It's got a way to go yet. We've spent a half million dollars and two-and-a-half years on it already and that half million dollars does not include about 20 industry people that have spent their time on it over this period of time. To give you an example, when you look at the past, the amount of offshore drilling that has occurred in the U.S. is a straight-line function just as clear as can be with the amount of acres that have been leased.

So when that equation was developed about a year-and-a-half ago, it just said: acres leased times some function is how much drilling you get. Well, that was great, as long as you were having some years with no leases and others with very small acreages leased. That's what you look at in the history. Now, all of a sudden we're talking about three million acres in a year. I don't think that drilling we did at five hundred thousand acres a year has any relationship at all to what kind of drilling will occur at three million. To me, it couldn't be a straight-line function anymore. I know there are drilling bottlenecks in the next few years, so there's a modeling area that needs improvement. The best TERA model that's around is the one now and on the lower 48 and onshore production. I think it's very good for right now.

DELEGATE: Is there going to be any future development?

HARDY: It's extremely flexible and built with the idea in mind of not only updating with current data every six months but adding to it constantly. The FEA will spend a lot of money working on the oil and coal sections of it.

DELEGATE: I'd like to direct this to Mr. Kress. The recent oil crisis or last winter's gasoline crisis, let's say--during that time I know people who were working at oil refineries and the refineries were only running at say half capacity. I also know truckers who were laid-off from trucking crude oil because the refinery was shut down because all of the gas tanks were full. They didn't want to sell the gas at those prices. Also, there were many reports that there were tankers lying off the East Coast which were waiting at docks to unload. And it seems kind of strange to me that this gasoline crisis all of a sudden developed when there were extreme environmental pressures and the oil industry wanted things done. Then as soon as the Alaskan pipeline legislation was passed, as soon as offshore drilling was brought under more consideration, gasoline became a little bit more available. I'd like you to address yourself to this if you would.

KRESS: Well, first of all, you say you know people. You can't, you know, describe the whole industry from knowing a handful of people. Some refineries are down all the time. For instance, we've had to cut back on our gasoline production this month because we had a problem with our catalytic cracker. Do you know what a catalytic cracker is? Briefly, it takes heavy oil and makes light oil out of it; it makes gasoline out of asphalt. I could describe it more if you're interested. The Unit had to shut down for maintenance so we had to cut back that refinery; we didn't do it purposely. A refinery that's operating is making money. One that's shut down is not. Now, these ships offshore--there are always ships offshore and there's a reason for that: It's because those ships in order to unload have to have a tank to unload into, so there's usually a ship or two off every port waiting for its turn at the dock. Now, last year, you know, I've been on both sides of this question--there were some ships lying offshore, and I'm sure they were looking for a price increase. But you've got to remember something when we talk about the oil industry. The industry consists of three chunks. These are the majors. They do about 70% of the business and we have a lot of independents. The independents are guys that scrounge crude oil wherever they can. They buy product. They buy blending stocks. They do it every morning. It's a day-by-day operation. That's the second chunk.

The third chunk is a bunch of brokers, and you can do this if you want. There's no objection to it; you can go around the world some place and find some oil and go out and lease a ship for one trek across the Atlantic. Then you could go find yourself a customer in New Jersey and deliver it to them. Well, those brokers, they're cagey individuals. Their income, their family's income, depends on what they buy and what they sell. The difference is their profit. Obviously, if they bought it at 50¢ a gallon and can sell it at 60¢, they don't make as much money as if they sell it at 70¢.

The other part of their cost benefit analysis is that the ship is costing them maybe ten thousand dollars a day. They have to make a calculation: If I sit here for three days that's going to cost me thirty thousand and the price is going to have to go up 15¢ a gallon. There are a few of those guys around, and it's their business. They are brokers. They don't own a refinery. They don't own a ship. All they do is they go someplace and buy. They lease a ship and then they find themselves a customer. It's done all the time.

Now, as far as the shortage last year was concerned, only 6% of the crude that we are processing came from Arabia. Six percent. Well, that is a chunk off the supply curve, you know, and when you're on the fence, 6% is even a lot, but the point is that we are importing a total of about 20%. The majority of that comes from Arabia. However, it first goes to Europe to the big refineries. There it is converted into products and then they ship the products to us. So, although the Arabs only cut us 6% in crude, they indirectly cut us out of damn near 20% of the market because they wouldn't sell crude to the Dutch for making products to ship to the U.S. Follow me? So, 20% that's a big lever. When you're short, one gallon is significant.

DELEGATE: Has Shell made a practice of shipping oil out of the U.S. beyond the territorial limit and bringing that oil back into this country and labeling it as foreign oil?

KRESS: Never.

DELEGATE: What I wanted to say, Mr. Kress, was this: I personally in the course of an investigation last year in February and March ran across an individual who had been a crewman on a ship that belonged to a company that I'm not going to name right now who was doing exactly this.

KRESS: Could be.

DELEGATE: And it was done as a regular practice over a period of several years. It was not an isolated incident, and he had documentary proof which is now buried in a Senate Sub-committee (and we can't get a hold of it for some odd reason) which I saw and listened to, which proves beyond a doubt that Shell and Exxon and one other country are, in fact, engaging in this practice exactly.

KRESS: You're talking about U.S. Shell?

DELEGATE: I don't know whether it was Shell U.S. or not.

KRESS: I can only really speak for Shell U.S.

DELEGATE: I can't see where it would help a foreign company to ship our oil. I mean I don't believe that they have oil in this country they could ship out and re-label as foreign oil, but anyway, my point is I think there is a credibility gap. I think there is a credibility gap from your particular company because I have run into it, and I think this is the worst thing an oil company can do is, I think, that. I think it gives you a bigger problem than anything else you can do.

KRESS: Well, I can only tell you that I wouldn't have anything to do with it. I would not condone it, and most of the management people that I know of would not condone that kind of thing. We are a very responsible company.

DELEGATE: Following along the same lines of thought, what are the moral implications of Shell selling from its right hand in Arabia to Shell in its left hand in the U.S.?

KRESS: I don't understand that question.

DELEGATE: How big a role does Shell play in procuring the crude in Arabia through Amaravco and some of the other multi-national companies?

KRESS: Well, first of all, we domestically produce oil. We produce something like 65% of what we consume in this country. The other 35% we buy from domestic pipelines. As far as I know, up until very recently, when domestic crude is getting short because we haven't been exploring, we have been buying wherever we can get crude oil. The worst part of that is we've had to resell that because of the allocation business; we haven't been able to even run at full capacity because we couldn't get all the crude we needed. Now, how that relates to your question, I don't know.

We have probably bought oil on the world market from our friends overseas, I don't doubt that. But remember, for instance, that Shell Oil U.S. is a domestic company. We're controlled by the laws that protect minority stockholders, for instance. We're in competition. We have always practiced competition with our colleagues overseas. We market against them in many areas. That's kind of a rule. We have to play that game. If we've done anything wrong, it was done illegally; it was done by some characters who were trying to make points some place. We occasionally fire people who do stupid things like that because the management--and I can only say what I know--they don't condone illegal things.

DELEGATE: Mr. Hardy, why are the gas people so negative concerning naphtha gasification when technology in this area is more advanced than coal gasification?

HARDY: The reason why we're so negative--I said briefly in my talk--the first problem was government; the second problem--the existing problem--was price. At first it was the Office of Oil and Gas in the Department of the Interior and the Oil Import Appeals Board; then the Office of Emergency Preparedness; then the Treasury; then Governor Love and his energy office and then Simon and the FEA. In that order, the government denied import allocations to the companies that wanted to import light liquid hydrocarbon feed stocks.

I'll just talk about naphtha instead of all the other feedstocks. We were denied import allocations because--oh, for a lot of reasons--a lot was political, a lot of it was just that the gas industry did not lobby as well as some others did. And that's a big factor in the way our government works. And then, when we got into the oil allocation system, we were denied allocations. Sawhill says he's coming out in the next few days, finally, with the SNG (synthetic natural gas) allocation rules. I think I have said many times that what we will get is the allocations for the plants that have already been built and those that are under construction. That's about a dozen to 14 plants. They will be given their feedstocks, but they'll get them on a case-by-case basis. I don't care what the regulations say. They'll get it by individual plant analysis and this way the FEA will make sure that no other plants get any feedstock.

There's very clear evidence that they have this in mind because FEA is talking about taking the allocation program off propane which is another possible SNG feedstock, but they say, we'll still have the "no-new-user" rule. And, that "no-new-user" rule they say is to prevent SNG plants from using propane. That's hard to argue against because SNG plants could swallow all the U.S. propane very quickly. So, I think that's probably not a bad rule at all, but for the naphtha I can see no reason for it at all. Now what's happened is the companies that have been denied access to naphtha--to foreign naphtha and to domestic naphtha--their purchase options have run out. Now the price has gone up to the point where it's so high that nobody wants to build a naphtha gasification plant anyway.

Naphtha was about 35¢ on the world market a couple weeks ago, and you multiply that by the 9 gallons it takes to make a thousand cubic feet of gas, and you're talking about 3 dollar gas, and that's just too much. So the negative, my negative viewpoint, is that right now if you don't have a long-term contract for naphtha that you made a couple of years ago when it was still much cheaper then you're just not going to go after it anyway. I think it's a horrible mistake on the part of government. The reasons that they used were no good. The inefficiency reason is not valid. Any feedstock that's denied an SNG plant will be burned up in an automobile engine.

DELEGATE: Or put in a petrochemical plant.

HARDY: Well, you see the petrochemical industry says any feedstock an SNG plant gets, they won't get.

DELEGATE: Well, that's ridiculous also.

HARDY: If it's worth more to the petrochemical plant, they will take it. If you have got an allocation system like you do now, it will be given to the petrochemical plant. The two industry demands are small--petrochemical feedstocks require 3% of the naphtha, and we want 2% right now. We would like more. So there is a whopping 5% of the naphtha for feedstocks--while 85% of it goes into gasoline. The efficiency argument is invalid. Naphtha will be used for something that only has one-third the efficiency of the SNG use.

MEETING FUTURE ELECTRIC POWER NEEDS

Harold L. Falkenberry, Chief, Power Research Staff
Tennessee Valley Authority

THE GROWING ENERGY DEMAND/SUPPLY GAS

Putting the current U.S. energy needs into perspective, I would like to quote from "Energy, Economic Growth and the Environment," published by Resources for the Future in 1970:

> "Only about one-fifth of total electrical (demand) growth is attributable to population increase, and as much as 80 percent to growing levels of per capita use. As a corollary calculation, one can say that a halt to population growth, everything else being equal, might scarcely have affected the rising volume of electric power use; while an unchanged volume of electric power use since 1950 would, in order to accommodate rising per capita standards, have required a 1970 population level of around 50 million--the figure for the year 1880!
>
> "The nearly one-fourth of primary energy consumption that went into electric power generation in 1969 is expected to rise to one-third by 1980, to over 40 percent by 1990, and to essentially one-half by the year 2000.
>
> "Growth in residential electric power consumption is expected to parallel overall electric demand growth--that is, at an annual rate of 6.7 percent for the time span 1970-2000. This implies a per capita growth of 5 percent yearly, or per household of 4.7 percent yearly. The average residential customer's electric power consumption would grow from 6,500 Kwh in 1969 to 27,200 Kwh in 2000."

The one major sector of the energy market which is for the most part presently commercially out of reach for electricity and therefore coal and nuclear power is transportation. Even here increased electrification of railroads and mass transit systems appears certain to occur in the years ahead. Automobile and air travel, two large and rapidly growing uses of energy, must continue for the most part to rely on hydrocarbons, petroleum products, or substitute petroleum products produced from coal and oil shale for the foreseeable future. However, the option of limited range electrified vehicles for urban use is one that could become available much sooner than many expect. Electric vehicles either storage battery or fuel cell powered vehicles could provide immense environmental benefits in many of our major cities.

As other energy sources become more scarce, we may see more and more dependence on electric space conditioning for the home in order for us to utilize our more available coal and uranium resources, which are either essentially impossible or environmentally difficult to utilize for this purpose except through conversion to electricity.

ACTIONS TO PROVIDE NEEDED TECHNOLOGY

Meeting this demand will require a massive national effort--the resource requirements will be immense, and we must go about the task in a logical manner or we shall fail--we have to begin with in-depth technological assessments of near-term and long-term possibilities, their arrangement in some orderly strategic plan, the assignment of priorities and funds and, finally, implementation and management of individual projects. As one major step in meeting its responsibilities in the energy field, the electric power industry in the United States organized the Electric Power Research Institute (EPRI) in 1972 to provide this research leadership and to extend technology needed to help meet future electric energy needs reliably, economically, and in an environmentally acceptable way.

The Institute now is sponsoring 1972 research projects valued at more than $178 million for nuclear safety, engineering, and operations; new technology for using fossil fuels and other energy sources; energy supply and demand studies; energy conservation; environmental impact programs; and electric power transmission and distribution improvements.

Figures 1-5 explain the organization and project areas of responsibility for the Institute's four technical divisions.

EPRI has been recognized as an authoritative electric energy information resource. It is fast becoming a focal point for analysis, planning and utilization of the R & D resources of the Nation's public and private electric utility industry and the Federal energy agencies concerned with electric power.

SITUATION ASSESSMENTS

All basic forms of primary energy, fossil and nuclear, upon which the electric power industry is very dependent have experienced serious problems, either in their availability or in their use. I need not dwell on the oil and gas supply picture except to point out that combined they have supplied almost half of our electrical energy in recent years. Both are in short supply at the present time, particularly gas. Oil supply is fraught with the uncertainty of international politics, and our assured sources of supply are being earmarked for those uses where alternatives are not available.

Coal seems to have faced one barrier after the other in its long struggle to remain a key source of energy to the Nation. Its use in homes and railroads has all but disappeared and today it is used chiefly under industrial and utility boilers and in the metallurgical industry. But even under boilers, the extent of its future appeared uncertain as nuclear power technology evolved and oil and gas competition continued. Now just when it seems clear that insufficient oil and gas will be available and nuclear power's growth is inadequate to meet the needs, Federal new source standards for SO_2 were promulgated which may vitually rule out the use of most of the Nation's developed coal resources for new power plants.

Many state and local pollution control authorities have essentially the same regulations to apply to existing plants. These standards were presumably based on what was judged to be available stack gas cleaning technology. We maintain that satisfactory technology didn't exist then and still doesn't. We do expect that someone will succeed in debugging his scrubbing process within the next couple of years, so that a utility will at least have that option, even if the cost is much higher than earlier predicted.

There are other possible future options for the use of coal that are being explored, but I need to stress that these along with stack gas scrubbing are POSSIBLE FUTURE OPTIONS and NOT commercially available, reliable technology for which equipment can be purchased today.

One of the alternatives to removing sulfur dioxide from power plant stack gases is to convert the coal to a clean fuel free (either a liquid or a gas) of sulfur before burning it; and, there are reasons in addition to the obvious environmental advantages why we are interested in clean fuels from coal.

One incentive would be reliability. Many of our boiler outages result, directly or indirectly, from the perverse nature of coal and its impurities both before and after burning.

Another incentive would be resource conservation--economics and efficiency--all obviously interrelated. For example, a combined cycle gas turbine-steam power plant is estimated to cost less to build and would consume less fuel than a conventional coal-fired steam power plant. But, because of the gas turbine, the plant requires very clean fuel--either natural gas or a petroleum product--both of which are becoming too scarce for use in bulk electric power generation. Processes which convert coal to a clean gas or liquid would, of course, give us another option here. And, once we have a clean fuel, we have still another potentially attractive option--the fuel cell.

Fuel cells are essentially large primary batteries using a continuous flow of fuel gas and air (or oxygen) to the electrodes to provide a low-voltage direct current.

The fuel cell is the only device we know of that is theoretically 100 percent efficient. This is so because it converts the chemical energy of the fuel directly into electricity instead of going through the less efficient steps of the conventional heat-power cycle. Even so, as a practical matter, probably the best efficiency we can hope for in the near future will be something like 60 percent.

The fuel cell is not, however, going to operate directly on coal. It is going to have to operate on a very chemically active fuel such as hydrogen--which we can produce directly from coal and water--or indirectly from nuclear electric power by using the electric energy to decompose water into hydrogen and oxygen--or possibly by some more exotic process. But what I'm trying to say is that fuel cells must operate on a secondary fuel and from the energy supply point of view, we have to identify a primary energy source.

Fuel cells are being developed now by Pratt and Whitney Aircraft under sponsorship from the American Gas Association and several investor-owned electric utilities. Several of the utility sponsors have placed orders for 28 MW prototype fuel cells--about 60 units have been ordered--subject, of course, to satisfactory performance of a developmental device. Delivery could begin about 1977.

However, there are two possible ways in which we may be able to burn coal directly--meet environmental standards and gain the benefit of the more efficient power cycles.

One approach is the magnetohydrodynamics power cycle in which super hot combustion gases (5000 degrees Fahrenheit range) with potassium or cesium added to further enhance the electrical conductivity are expanded through a magnetic field. This is the same electrical principle as the conventional rotating generator passing a conductor through a magnetic field and an emf will be generated at right angels to both the magnetic field and the direction of motion. There are a couple of details to remember here:

1. The electric power is dc but, in this case, we can get voltage in the hundreds and even thousands as opposed to two or three volts or less from fuel cells or solar photovoltaic devices.
2. After the gases have cooled to about 3500 degrees Fahrenheit even with the added cesium or potassium, they are no longer conducting. Thus, below about 3500 degrees Fahren-

heit for combustion gases, MHD will not work. However, there is still too much energy in the exhaust gases from the MHD dust to be thrown away, and the remaining heat has to be utilized in a conventional steam power cycle.

3. The very high combustion temperature would appear to magnify the problem of formation of nitrogen oxides.

EPRI is funding work on MHD. TVA, in connection with the Department of the Interior, has been funding work on direct firing of coal in an MHD device at the University of Tennessee Space Institute at Tullahoma. The size of the equipment is modest--duct cross-section is about 4" X 6". However, it's been very successful so far, and we are very pleased with the results.

Another way we may use coal directly is in a relatively new boiler concept called fluidized bed combustion. Because of the much lower combustion temperatures in these devices, it is possible to introduce limestone or dolomite directly into the combustion zone to trap the sulfur dioxide released from burning sulfur containing coal before it leaves the combustion zone. Fluid bed combustion operates below the ash melting temperature, and the turbulent combustion zone appears to offer enough abrasive action to keep the heat transfer surfaces clean and to promote heat transfer but is not so abrasive as to destroy the tubes.

This concept appears to offer the economic promise of lower capital cost than either a conventional boiler equipped with stack gas scrubbing equipment or a power plant with coal pretreatment facilities and would avoid the loss of Btu's incurred in the coal pretreatment plant. It appears capable of generating sufficiently high working fluid temperatures to permit use of a combined cycle power plant with the attendant higher overall plant efficiencies. And finally, in these days of fuel shortages when the electric utilities are being forced to accept lower and lower quality coal, the fluid bed combustion boiler offers the capability to digest without gas pains even the lowest quality coal--possibly a necessary requirement for the future.

And now let's turn to nuclear power.

As some of us among the more experienced generation--I carefully avoid referring to my contemporaries and myself as the older generation--can tell you a lot about, the development of the current thriving commercial nuclear power industry from the World War II beginnings of a nuclear energy program in the United States has been long--roughly 25 years to the first truly commercial sale--and uncertain and circuitous route with a lot of dead ends and detours along the way. And, after commercial sales began to be made, we have continued to encounter a series of problems--construction and licensing delays from a variety of causes and opposition by various groups and interests. As a result of these factors and because of the effect of inflation, we have experienced steeply rising costs associated with nuclear power plants.

Hopefully, we have seen the worst of all these problems and future light water nuclear power projects can be undertaken with increased certainty of meeting projected completion dates and cost targets.

In TVA's case alone, we have under construction or on order 13 large nuclear power units (~1200 MW each) to be installed in five nuclear power plants. These units will meet the bulk of our expected power needs through 1982. And we are evaluating proposals now from nuclear steam supply system supplies for four to six additional 1200-1300 MW units for commercial operation commencing in the period 1982-1984. Orders for these additional nuclear steam supply systems should be placed before the end of this year.

Thus, it is that by about 1984 when the units we have under construction, on order, and for which bid invitations have been issued, our system's commercial nuclear capacity will be nearly 22,000 MW out of a total of nearly 47,000 MW.

Technology continues to evolve, of course, and it is worth noting that the bid invitations issued in February of this year, for the first time, permitted the high temperature gas cooled reactor (HTGR) to be considered, and a proposal was submitted by the one HTGR supplier in the United States, Gulf General Atomics Company. The HTGR is cooled by pressurized helium, it produces more efficient steam conditions, offers a somewhat higher fuel conversion ratio, and should extend our nuclear fuel reserves by utilizing thorium.

In addition to the commercial nuclear power plant capacity we have planned, the Clinch River Breeder Reactor is being added to the TVA power system. It will be built at a site here in the Oak Ridge area.

Pete Van Nort is going to tell you about the Clinch River Breeder Reactor Project, but I'd like to make a few general remarks about breeder reactors.

The commercial nuclear power reactors--the only nuclear power options that we have now--utilize only a small fraction (between one and two percent) of the energy potentially available from the uranium we mine. Our known and reasonably assured economically recoverable uranium reserves are insufficient to permit the continuing, increasing commitment to nuclear power at currently projected rates for more than a very few decades. However, the breeder reactor will permit us to utilize uranium resources much more efficiently--perhaps 30 times so--thus extending the life of our uranium reserves to centuries. This, of course, will provide us with the time needed to develop the fusion or controlled thermonuclear reactor.

When we consider further the decreasing availability of petroleum and natural gas for electric power generation, and note the increasing problems we face in getting enough coal out of the ground, and consider further the increasing demands on coal as raw material for substitute natural gas and for substitute petroleum products, the importance of the breeder becomes clear.

Light water and HTGR plants require uranium enrichment services, and this looms as one of our biggest supply problems. Uranium enrichment capacity and nuclear power production go together, side by side. By the early 1980's, our present gaseous diffusion plants will be operating at full capacity, and additional sources of enrichment capacity will be needed in the ensuing years. And this will require a tremendous new capital investment and construction program regardless of whether the Nation finally elects to use the gaseous diffusion process or--say--the gas centrifuge.

As we move in the future toward a larger and larger percentage of nuclear powered generating capacity, we encounter an economic problem in that the capital investment in nuclear plants and their fuel is very high, and when installed capacity of nuclear plants reaches much beyond the base load requirement, we encounter economic penalties because during off peak periods we must cut back on their generation. However, alternate modes of generation may be no bargain, either, in terms of energy cost.

One way for the utilities to produce and deliver the most kilowatthours of energy with low cost nuclear fuel is to install energy storage facilities to permit the nuclear plants to operate at base load--even when system demand is low--and therefore at their lowest cost--and to level out the fluctuating consumer load using energy storage devices.

However, the potential advantage of energy-storage systems for application to utility power peaking and load leveling reaches beyond just increasing utilization of low fuel cost nuclear base load units but also a significant reduction in peaking energy costs and opportunities for conservation of fossil fuels. In addition, for many types of energy-storage systems, there is the promise of (1) minimum environmental impact, (2) distributed storage and siting which results in transmission and distribution savings in investment, (3) modular design with short installation lead time, and (4) a reliable spinning reserve. In addition, the increased utilization of energy storage devices should reduce somewhat the need for added generating capacity to meet our increasing electrical energy demands and offer the possibility for lowering new capital requirements.

Of particular interest in energy storage is the projection that within ten years, high-capacity secondary electric storage batteries will be commercially available. The apparently leading contenders are sodium/sulfur, lithium/metal sulfide, and zinc/chlorine. Serious efforts also are underway to use hydrogen for storing energy. One utility is now operating an electrolyzer during off peak times to produce hydrogen, which then is stored in a metal hydride (iron-titanium) and subsequently converted to electricity with a fuel cell (12.5 kW).

Other long-term energy sources such as fusion and geothermal will be utilized principally for the generation of electricity or on-site process heat. Solar energy, on the other hand, will probably be economically feasible for home and commercial heating before it becomes competitive with other energy sources for central station power generation. Its diffuse nature makes it an ideal source for meeting a portion of our space conditioning and hot water needs if low cost solar collectors and energy storage systems become available. The important point to be made here is that we have both the resources and the technology to sustain anticipated growth in the electrical energy area for many years to come as well as the prospects of developing additional technology which would provide essentially an infinite supply of electrical energy utilizing breeder reactors and fusion. Increased electrification of our energy system will permit our diminishing supplies of oil and gas to be used for petrochemicals, plastics, fibers and other uses where hydrocarbons are essential.

Let me now return to the two principal concerns identified earlier relating to increased electrical consumption. It is an indisputable fact that there are thermodynamic limitations which limit our ability to convert thermal energy or heat to any mechanical form, including electricity. However, it should be recognized that at the present time, we are far from bumping up against that limitation.

Early in the industry's history conversion efficiencies (heat to electrical) of five percent were common. Today the best fossil fuel plants achieve a 40 percent efficiency. Water cooled reactors, still in their infancy, operate at about a 33 percent efficiency. In both cases improved performance is limited by the availability of satisfactory materials that would permit utilizing energy available at higher temperatures. Thus, advances in materials technology could permit today's conversion devices to operate at still higher efficiencies in the future.

Now, turning to electric power transmission and distribution, the present cost of underground distribution in a subdivision or community generally ranges from about 1.5 to 2.0 times the cost of new overhead distribution lines. This cost differential appears to be decreasing, and there are indications that more new distribution will be installed underground.

The cost of high-voltage, high-capacity underground transmission circuits, however, is considerably higher than overhead lines (10 to 30 times), and because of this large cost difference, overhead transmission will continue to be the most practical and affordable way of transmitting large amounts of power over long distances for many years to come.

Considerable research effort is being carried out to increase the power carrying capability of ac overhead lines, thus reducing the land requirements for transmitting a given amount of power. Also, research is being done to develop high-voltage dc transmission lines and equipment. The United States has initiated a collaborative research effort with the Soviets in our energy exchange program to explore all aspects of high-voltage transmission.

In the more distant future, superconducting transmission systems could permit the movement of large amounts of power over long distances with very low power losses. At the present time, the economics would not appear favorable for smaller capacity superconducting systems. However, they could provide siting flexibility for large reactor complexes far removed from population and load centers if such siting becomes desirable. Some scientists have even suggested that energy storage in large superconducting coils could someday be used for load leveling purposes. In superconducting technology, as with many of our advanced conversion systems, materials technology (only at the other end of the temperature spectrum) holds the key.

CONCLUSION

The solutions to our energy problems can be reached only through careful planning and full cooperation among all elements of the energy community, Government, and the public. We have no alternative but to develop as rapidly as possible those technological options necessary to take full advantage of all our energy source and conservation options in an environmentally responsible way.

It is encouraging to know that each of you as members of the Energy Youth Council has seen fit to help organize the Citizen's Energy Workshops that can do so much for public understanding of the challenges before us and to conduct workshops of this type in your home areas. Hopefully, your involvement in local energy problem-solving projects will pave the way towards public understanding of the relationships between energy need, energy production, economics, and environment. This will make future technological progress so much more meaningful in terms of the benefits it produces.

FIGURE ONE

MISSION OF EPRI

BRING ADVANCED TECHNOLOGY INTO PRACTICE, INCLUDING:

* SCIENTIFIC FEASIBILITY
* ENGINEERING FEASIBILITY
* COMMERCIAL FEASIBILITY
* UTILITY INTEGRATION

FIGURE TWO

EPRI SCOPE OF ACTIVITIES

* FUEL EXTRACTION
* FUEL CONVERSION
* ENERGY GENERATION
* ENERGY STORAGE
* ENERGY TRANSPORTATION AND TRANSMISSION
* DISTRIBUTION
* UTILIZATION
* SYSTEMS INTEGRATION

FIGURE THREE

EPRI SUPPORTING ORGANIZATIONS

MEMBER UTILITIES OF:

* American Public Power Association
* Edison Electric Institute
* National Rural Electric Cooperative Association

FEDERAL UTILITIES:

* Bonneville Power Administration
* Tennessee Valley Authority

FIGURE FOUR

EPRI ORGANIZATION CHART

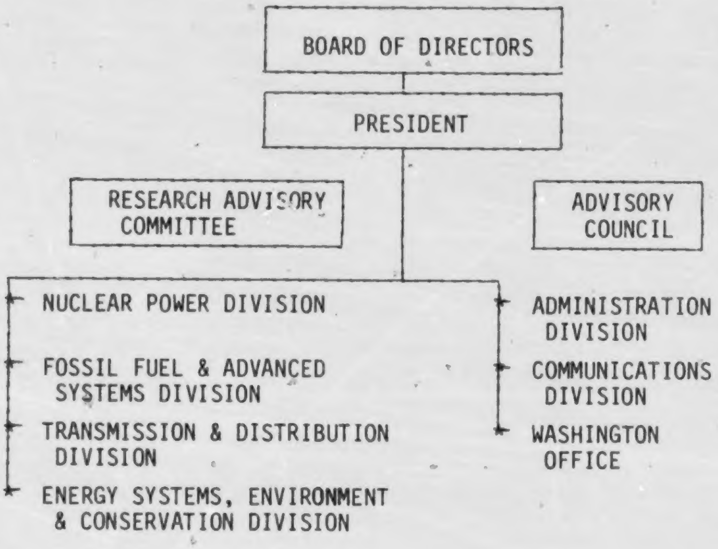

BOARD OF DIRECTORS
PRESIDENT
RESEARCH ADVISORY COMMITTEE
ADVISORY COUNCIL
NUCLEAR POWER DIVISION
FOSSIL FUEL & ADVANCED SYSTEMS DIVISION
TRANSMISSION & DISTRIBUTION DIVISION
ENERGY SYSTEMS, ENVIRONMENT & CONSERVATION DIVISION
ADMINISTRATION DIVISION
COMMUNICATIONS DIVISION
WASHINGTON OFFICE

FIGURE FIVE

EPRI FUNDING

1973

0.067 MILLS/KWH
$70 MILLION

1974

0.100 MILLS/KWH
$100 MILLION

1975

0.115 MILLS/KWH
$130 MILLION

1976

$180 MILLION

QUESTION AND ANSWER SESSION

"Increasing the Supply of Coal"

Speaker: Dr. Harold L. Falkenberry, Chief
Power Research Staff, Tennessee Valley Authority

DELEGATE: How much MHD research work is your organization doing right now, and when do you hope to have it become commercially available?

FALKENBERRY: MHD is a long way off as a commercial reality. We're sponsoring some work over at the University of Tennessee Space Institute--we, and the Department of the Interior. The Department of the Interior is putting in more money than we are. What we did was exert a lot of pressure on the Interior to stop fiddling around. All the MHD researchers wanted to burn clean fuels in their electrical equipment in their devices, and coal is a perverse material. Its got sulphur; its got ashes; and its got nitrogen that gives off nitrogen oxides. Everybody likes to burn clean fuels in their MHD ducts and say: "Look, we've put in some fuel and we put a volt meter on the duct and we generated power." Nobody argues that. We don't have natural gas, and we don't have any kind of clean fuel and for the most of the utilities, if we're ever going to use MHD ducts, we've got to use coal, so let's get with it and quit shying away from the problems.

Over the entire country that was what was happening. So, we found that the University of Tennessee Space Institute over here was willing to try that. They have got a little MHD duct that has a cross-section of about 4 inches by 6 inches and over the past two years they've gone from the point where they couldn't run over about 10 to 20 seconds with coal up to the point that they can run for about an hour. Then when this pressurized feeder system runs out, they have no choice but to stop and recharge it. Based on what I've seen, if they had a feeder system that would run for 24 hours, they could run it for 24 hours. I think we are making progress, but that's a long way from a commercial MHD device.

DELEGATE: O.K. Also, are you engaged in any cooperative work with the Soviet Union or is the Department of the Interior engaged in any cooperative work with the Soviet Union in the field of MHD?

FALKENBERRY: You probably know that President Nixon and Brezhnev from the Soviet Union announced, I think in May of 1972, about this agreement for scientific and technical cooperation. They agreed that they would cooperate in the areas of space, environment, and energy and one of the working groups in energy is MHD. A man from the Department of the Interior, Bill Jackson, is heading that up, and I'm a Project Coordinator in another area.

I get letters from my bosses telling me in effect, "Look at what Bill Jackson is doing and why aren't you people doing as well as he is?" I really can't tell you in detail, but I do know that Bill has made arrangement with the Soviet Union. They have got this large so-called U25 facility which is an MHD unit that is designed to generate about 25 megawatts of MHD power and to recover the energy for about 50 or 75 megawatts more. And so, rather than the U.S. having to build a large test facility to test these large MHD ducts, I think Jackson has arranged to ship ducts manufactured in the U.S. and have them tested over there. What's going to be done in this country, I'm not sure. The Soviet machine, incidentally, burns natural gas.

DELEGATE: The problem we're working on at M.I.T. with the MHD generator is that

61

due to certain fluid effects it shorts out and after a certain time period...

FALKENBERRY: Is that the helium or the combustion gases from the liquid fuel?

DELEGATE: What happens is that you have the whole effect...

FALKENBERRY: Are you dealing with combustion gases or helium?

DELEGATE: I think helium probably. But, anyway, our problem is that with these MHD generators you have the fluid flowing on a magnetic field and that induces the electrical field. There's a type of MHD generator which seems to be the best kind called segmented electrodes. You have a series of the electrodes insulating and on top of that is formed the gas. What happens is at a certain point in the MHD operation there is a short from one electrode to another and with the short is associated various Lorentz forces which destroy the electrical wall. Plus, I have also heard that there is some problem with the materials in order to withstand such a high heat.

FALKENBERRY: You're right. I think I would just add to that that these are relatively small ducts that we're dealing with now. When you go to an MHD duct that would be of commercial electric power generating size, it would be as large as a room in cross-section, or larger, and I think, the fluid mechanic's problems in that kind of a duct is that it's one thing to achieve a uniform flow that you think you can control in a four by six-inch duct and it is something else entirely to push it across a room. All I can do is try to answer any problem you want to point out to us. I'd say yes, we've got a long way to go.

DELEGATE: With the fluid there is also a problem since the interaction with the fluid and the electrodes forms a boundary layer and that boundary layer turns out to be turbulent.

FALKENBERRY: This project we have over here at the University of Tennessee Space Institute in burning coal turns out ash instead of attempting to insulate the wall. We use water-cooled electrodes over there so the first thing that happens is that the ash and the coal vaporizes as it goes into the duct, but the temperature at the wall is cool enough to condense it. And so we end up with a sort of insulating layer of ash along there. So where you start out with a duct that you think is the segmented electrode that you're talking about (and incidentally John Dix makes his diagonal here), we start out with this carefully insulated electrode one from the other, and after about two seconds of operation with coal, you end up with a fairly uniform layer of coal ash. This seems to make no difference. He still picks off his power and goes on fine. When he started out, by the way, he got some rocket fuel that had aluminum in it, so that some of his earilier experiments were burning rocket fuel and he laid down a layer of aluminum oxide, but it didn't seem to make any difference. So he tried coal and it turned out that the coal ash is, of course, aluminum oxide and iron oxide...

DELEGATE: But the ashes shouldn't make any difference anyway. It just has to do with the interaction with the fluid state and the B-field.

FALKENBERRY: Well, they're not getting away. Since they cover the electrode, he wondered if they wouldn't impede the flow of power.

DELEGATE: To induce the electrical field, I think that goes through the insulation, that is, it is as if you have a rubber balloon and you charge it up rubbing it against your shirt. If you put a piece of paper on it, there's still a field going through the paper. The same occurs with the coal ash.

FALKENBERRY: Up your way, by the way, the Electric Power Research Institute and the Interior Department are funding some work with Avco out at Everett, Massachusetts.

DELEGATE: You were talking about fuel cells. Are you familiar with the hydrox fuel cell?

FALKENBERRY: Hydroxy.

DELEGATE: Hydrogen-oxygen?

FALKENBERRY: Yes.

DELEGATE: On a system say of 2 kilowatts for fuel cells, do you know what type of efficiency you're going to be able to obtain on a standard production model and what that would cost approximately?

FALKENBERRY: No. Part of the reason about the cost is that you probably can get a capital cost from Pratt and Whitney and probably a guaranteed minimum efficiency. One of the things that concerns us is how long it will last and over what periods will you have to write it off. I don't think we'll know how long it will last or how long we'll have to write off the electrodes. Maybe some of the basic structure will last, but amperization is a big factor in electric power costs.

DELEGATE: I have one question of curiosity more than anything else, and that's that the Tennessee Valley Authority (TVA) is having very difficult times with nitrogen supersaturation in its hydro-electric facilities. What sort of problems has the TVA encountered with nitrogen in its dams?

FALKENBERRY: I guess the answer is I don't know. I don't think that we have encountered the same sort of problems that they have. At least I haven't heard about them. One reason may be that the head on our main river dams are something like forty or fifty feet in elevation from headwater to tailwater. We do have some higher dams back in the mountains about 400 feet from top to bottom, but I have not heard of any of this nitrogen problem downstream from any of our dams.

DELEGATE: Supersaturation of the nitrogen seems to be doing some tremendous damage to the aquatic life and this is the reason I was wondering.

FRADIN (FASST National Office): Do you know what the cause is of that problem?

DELEGATE: Just the water falling through the dam. It has to be de-nitrofied basically at the base of the dam. Many of the West Coast salmon and other important game and commercial fish are being killed because of the excessively high nitrogen concentrations in the water.

DELEGATE: One question I have is in regard to the scrubbers. My understanding is that once the limestone is blown into the scrubbers it's taken out as a kind of colloidal sludge of some kind, and there seems to be a great problem now with taking care of the sludge. Are you doing any research to try and determine what can be done with the sludge so that it doesn't become an environmental residue?

FALKENBERRY: You're certainly right in pointing that out as a problem and we do too. The answer is that we're not doing as much research as you might think right now. And I want to tell you why. We started out several years ago working with scrubbers, and we were using limestone. Most of you probably know that when you see a water pipe that no longer has a hole in the middle the deposits inside are calcium and magnesium. You're dealing with one of the most scale-forming materials you can find in calcium, but it's about the only material you can really afford to use.

But, in any event, we've just been doing everything we could to try to make the scrubber work and to keep the thing open and clear so that we can make the sludge. Honest to gosh, we had our hands full and we recognized it. We got some of the stuff two or three years ago and we recognized this problem. It's primarily calcium. What we thought we would make is calcium sulphate which is gypsum, and I tell people it's really alabaster that's not been formed yet, you know. In any event, it turned out when we finally got the scrubber to work, we make mostly calcium sulphite and not very much calcium sulphate. Calcium sulphate when it crystallizes out crystallizes into little rocks, and it comes down to the bottom and settles nicely. It's gypsum. Calcium sulphite, the kind we produce, seems to form in a little plate, like playing cards. It just won't settle. They stack up and just won't settle. It is colloidal, a little bit like quicksand, too much like quicksand. But, we were having so much trouble with the scrubber that we set that aside, and said, "If we ever learn how to make this scrubber run and produce the stuff, then we'll turn to seeing what we can do about it." We're at the point now that we do have to really get with that problem. It is a problem, and a serious one.

DELEGATE: So with the fluidized-bed combustion, you don't have this priciple. You form calcium sulphate, is that correct?

FALKENBERRY: Right. And the only thing is it's dry. It's not an aqueous slurry, it is a dry solid. You take the stuff out dry, and we could possibly get ourselves in trouble if we used a water sluice to haul it out, but sulphate ought to settle out anyway. We were assuming it will make mostly calcium sulphate so we tried to control sulphur dioxide years ago in a power boilder by pulverizing limestone and blowing it into the furnace. We were going to calcine it, make calcium oxide that would react with sulphur dioxide and give you calcium sulphate. We'd take that with an electrostatic precipitator and we'd be in business. Actually that worked, but it's very inefficient. We found for every theoretical amount of limistone that we blew in the furnace we took out about 10% of the sulphur dioxide and had we put in enough to take say about 80% of the sulphure dioxide, we'd have had nothing but a dust storm in there. Those are the kind of removal numbers that you have to get to meet the standards, so we gave up on dry limestone injection for SO_2 control.

DELEGATE: So then, as soon as you get the sludge in large quantities then you'll try and figure out what to do with it.

FALKENBERRY: No, no, I didn't say that. I said in the first place we want to get just our pilot plant. We're still building on the big scrubber, and so what we want to do is whenever we can get our technical people all through the pilot plant, we can tell them: "All right you worked yourselves out of a job there, and we've got you another job." So we're not waiting until we produce it in large quantitites; we're just trying to get to the point where we can tell the designers: "This is change no. 13. This time we think it'll work."

DELEGATE: Do you know if the flywheel could ever have practical application in transportation? Is there work being done now?

FALKENBERRY: We've said the flywheel, if you use the right materials, we see energy densities that would be equivalent to 100 watt-hours per pound, and even the old flywheels would get you about the same energy densities as lead-acid batteries in this ill-fated automobile I was telling you about. We were looking at these storage batteries for two reasons: one is huge, stationary electric power storage devices that will allow us to level our load, and secondly, we said: "Who knows, if we get a good enough battery, maybe it would help the electric automobile business." For our goal for a good electric storage battery, we were looking at things like sodium-sulphur and lithium-chlorine for high energy density batteries. We had set for vehicular application about 100 watt-hours per pound and about 100 watts per pound. If you can come up with something like that you ought to have a winner, or at least not a loser. With the more exotic single filament fibers for some of the flywheels and with careful attention to design to minimize the stresses, it looks like they might do it. There you wouldn't be so much plagued with the variable frequency business.

DELEGATE: Could you charge an electric motor? What would you charge it with then?

FALKENBERRY: Yes.

DELEGATE: You'd have to charge it fast and then use it slow.

FALKENBERRY: Right. Well, you won't use it all that slow, you know.

DELEGATE: Right.

FRADIN: Who's doing the research on that?

FALKENBERRY: They did some at Johns Hopkins and I think it's--hasn't CCNY changed its name? I think it's CCNY or one of the schools there in New York, and a firm out on the West Coast whose name I have trouble remembering.

FRADIN: Lockheed?

FALKENBERRY: Lockheed has done some, and the one called Brobeck Associates is the one that the Electric Power Research Institute (EPRI) has a contract with.

DELEGATE: I remember reading in the Post about a bus company that's doing some design from that. They have electric wires on the top and then it charges up the flywheel and from there they go a couple of miles on the flywheel alone. I think that something like that is either being done or is being planned in San Francisco.

FALKENBERRY: Years ago in Switzerland, there was a bus using old flywheel designs but it won't putt putt even a few miles. You have to stop and charge and go again. Some experimental flywheel buses are planned for the U.S., I believe.

DELEGATE: I think they're under construction right now, and they're going to be used in a couple of years.

DELEGATE: I have a question for Mr. Kress. I noticed in one of the many booklets that we were given a graph which showed that the level of wild-cat drilling for oil had been decreasing over the last several years. I was wondering what the reason for this was, and also, if you could please comment on the current state of the art regarding the determination of auspicious sites for oil exploration?

KRESS (Shell Oil Company Representative): It was principally a price problem. We were getting up until about a year ago something like 3.25 a barrel for crude oil in this country. That wasn't enough to justify it so the people with the money who have to go out and do all this exploration just couldn't see a worthwhile investment and with the extreme rates of inflation we've been having, that 3.25 was contributing like 3 or 4 percent earning power. That's not enough to get people interested. Now, what's happened recently, of course, is that with the increase in price in crude oil and natural gas which kind of goes along, there's been a big change in exploration. It's jumped 30 or 40 percent in the last three months. In fact, the big problem now is that everybody's crying for drill pipe and the necessary steel to get into that business. It's a price tag.

DELEGATE: Why does industry have a progressive rate structure?

KRESS: The big guys get a lower rate, and if you know anything about marginal economics, that's the way it is. If you run a plant, and you can add or double its capacity because say--let's take an automobile manufacturer down the street wants a big lump of power, you get all the economies up and down the scale going to that incremental consumer.

Now, there's a public utilities commission meeting today in New Jersey. The public utilities there are asking for rate increases and the Environmental Protection people have come back with a plan to reverse the schedule so that the more power you use the more it's going to cost you per unit of power. This is just an attempt to promote conservation.

DELEGATE: Does it promote conservation, or doesn't it?

KRESS: Well, that's the question. Obviously, if the cost of power goes up, there is going to be less interest in using power as an investment.

DELEGATE: If there were a short supply of electricity, then you don't need a lot because supply and demand can be met by small consumers, won't it? Won't your demand be met?

KRESS: Well, suppose there's a new factory being built someplace and it creates a lot of jobs which a lot of people are interested in. In fact, I think it was Monday that New Jersey in the State Capitol had a great big mass demonstration of the construction people. There's something like eight percent unemployment in New Jersey, and in the construction field, it's something like thirty percent.

So, they had something like 15,000 people clamoring for work in New Jersey. You see what I'm driving at? If this guy is building a factory one of the things that's going to influence whether he builds it at all or how big he builds it, etc. etc., is the cost of his energy. Now, if he's going to take a big lump of power, and he's going to pay a lot more than he's used to paying, will he open up that factory? It's a problem. That's what I meant before.

Life style is a question today. I don't know what's going to happen. Harold before said that there is going to be a change. I think most of us that have been following this thing think there will be a change, and I think the question is: "Is this going to be done strictly through governmental influence or is it going to be done through free market pricing, or through the other argument, between the private sector and the public sector? That is the question that's going on in the "Establishment", if you want to use a popular word.

FALKENBERRY: I would suggest a slow change over the years and no step changes.

KRESS: Well, there's always change, you know. The question is how steep is that curve going to be?

DELEGATE: A question for Mr. Falkenberry, please, a two-part question. First of all, how much coal ash is produced now by the TVA, and what's done with it?

FALKENBERRY: We burned last year something like 35 million tons of coal, and that coal probably had fifteen percent ash in it. If it were ten percent ash, it would be 3.5 million tons, so we managed to produce in addition to a lot of electricity around 5 million tons of ash. What we do with that stuff is generally we pond it. We sluice it out to a diked off area, and let the stuff settle. We have got acres and acres of ash which is very good construction material if anybody's interested.

DELEGATE: That's the next question I was going to ask you. Could you take this stuff and use a binding agent and make it into brick. The price of brick right now is enormous, just for regular brick. Would it be economical to make a brick?

FALKENBERRY: You've got the raw material of brick; it's the labor and other manufacturing costs that make brick so expensive. But, we're making progress. I forget exactly how much we sell, but it's probably less than ten percent of all the ash that we sell. But the trouble is you've got no idea how many bricks 5 million tons of ash would make.

KRESS: Believe it or not, just as a matter of information, one of our refineries for probably 20 years was a major coal-burner. We burned 1200 tons of coal a day because at that particular point in time coal was cheaper than fuel oil or gas.

DELEGATE: You could make the ash into a kind of concrete-like material which could be cast into buildings. The idea of casting whole buildings is...

FALKENBERRY: I didn't mean to be totally negative. There are specifications for the use of flyash of naturally cementatious material. For a long time, the Portland Cement Association had specifications for adding flyash to concrete. It turned out that the kind of flyash that we could collect from our plants didn't meet their specifications, and they wouldn't change their specifications. So, we went to our concrete labs and said: "Look, never mind these specifications. Let's just do some mixing and see what happens."

Well, it turned out that this flyash that we had was perfectly good. As a matter of fact, it makes concrete much better. For one thing, it's easier to work. A guy that trowels a lot of concrete will tell you that Flyash concrete is a lot easier to work. It comes out smoother, and not only that, it's long-term strength is higher. They tested these cylinders of concrete after either seven or ten days, and then after 30 days. The seven day test is not so good, but you just hang on for 30 days, and you've got yourself a real hunk of concrete. We did that probably about 15 years ago or longer and every coal-fired power plant and every dam that we've built has used the maximum amount of flyash that the mix would stand. In addition to that, we've got a deal with Marquette Cement Company over here in Nashville, Tennessee. They use that as an ingredient or raw material for the manufacture of cement.

We always have a total war at our Kingston plant, which is not far from here, for the flyash that we collect, to see whether Marquette's going to get it or home construction people. We are moving the stuff more recently. Some of the pondage stuff is going out of our Willis Creek plant up to a cement manfuacturer in Chattanooga. It turns out that if they use that material, they can increase the capacity of their kilns, so when cement gets in short supply, they are interested in using this waste material of ours.

KRESS: Don't forget shale because that's the big problem with shale--the refuse. The ash from the shale plant makes gobs and gobs, by volume ten percent, more than you put in. Again, for curiosity, I submitted a patent application for the shale business in which half of the shale volume will be cut, and you notice that sample I sent around, where it's polished, is a very nice looking tile. So I suggested that half of the shale be cut into tile and the other half be thermally decomposed to take the oil out of it. The ash, when you mix it with water, is a very good cement, so use that cement for putting that tile together. I did that just to aggravate the patent department. I don't think I'll get a patent.

DELEGATE: I'd like to know--my question is to Mr. Falkenberry--if you know anything about the real relative efficiencies of centralized heating, residential heating from fossil fuels and from electrical sources. You can generate electricity at forty percent which, of course, doesn't compare very well with the sixty percent that you normally get out of fossil fuels or fossil-fired furnaces, but transmission efficiencies are quite a bit different. Could you tell me about those?

FALKENBERRY: Transmission losses are not really all that much. They're roughly something like five percent of our total generation that is lost in transmission. It depends on the climate; but, if you look at the heat pump, for example, which you could call kind of an energy multiplier, the heat pump compares very favorably with other sources of energy for home heating. We don't recommend that anybody go in and put in resistance electric heat.

DELEGATE: Would either you or Mr. Kress know about the amount of energy used in transporting oil? I mean that whole system, from out of the ground...

KRESS: For every hundred barrels of actual products sold, we probably use on the average, I would estimate, about eight barrels of equivalent crude oil. That's a number that varies widely. A refinery, for instance, that produces sixty percent gasoline has a much higher fuel consumption than one that produces forty percent gasoline. In the process of converting, you use a lot of energy, so refineries vary from anywhere as low as four or five percent energy consumption relative to the crude process up to maybe thirteen to fifteen percent depending on how complex the refinery is.

DELEGATE: In the Soviet Union many of the coal fields are in Siberia so up to forty percent of the coal mined is used to transport the stuff from Siberia over to the manufacturing centers.

KRESS: How far is that, do you know?

DELEGATE: About 4000 miles?

KRESS: Anyway, that's one of the things that is being worked on now very diligently. That is, the transporting of coal through a pipeline. Is that the best way to do it? It takes a big investment.

DELEGATE: I was also wondering, where do you get the water?

KRESS: Assuming you can get the water. We're running out of fresh water in this country. That's another problem that's on the horizon.

DELEGATE: I was wondering if the TVA had done any work on making windmills for online capacity? I realize that in small operations the economics are terrible, but when you get into megawatt sizes, they begin to look a little better. Do you know anything about that?

FALKENBERRY: No, and since my job is in the research staff, if we'd done anything on it, I'd know about it. You can lay that at my feet and not one of my bosses' feet because really we've looked at the resources we have available, and we've put windmills pretty far down the list as far as what is going to give us some more energy on the time schedule. For example, we've assigned about the highest priority to getting the breeder reactor.

DELEGATE: In the project I'm working on we're considering total energy systems. Are there any plans for your future plants to make use of the waste heat for space heating or whatever?

FALKENBERRY: Not really, and I'll tell you why. It's not that we won't be wasteful of waste heat, but most of our plants, as you will find out, are fairly distantly located from places that could really use the heat; and the other point is that that waste heat is warm. It's not hot because we milk it for every kilowatt hour we can get out of it before we turn it loose. The conditions for cooling water, for example, in some of our plants is at full tilt. You add ten degrees Fahrenheit to the cooling water and some of our nuclear plants go up to 25 degrees, but generally, that's for recycling.

What your dealing with is extremely large quantities of heat at very low levels. For example, you take a forty percent efficient plant, well, take Bull Run, that plant burns somewhere in the neighborhood of 10,000 tons of coal a day. That's about forty percent efficiency, and so 4000 tons a day go out as electricity on the wire, around 1000 tons go up the stack everyday in stack heat losses and 5000 tons of coal, or the equivalent, go in that condenser cooling water. So, it's a tremendous amount of heat. We're doing a lot of work on agriculture. We have raised some of the juiciest tomatoes and cucumbers you ever saw in greenhouses heated and cooled with waste heat, and we've got a catfish project over here at Gallopin that turns out catfish which can convert food to body weight more efficiently than a cow or a hog or almost anything else you can find. We've got ten channels for using it, but they operate at pretty high temperatures. It has to be about 80 degrees. Below 60, they hardly eat, and they don't gain at all, but they're pretty hardy. But anyway, we've got a real interesting project going on over at Gallopin power plant on growing catfish.

FRADIN: What do you do with them after you grow them?

FALKENBERRY: Well, actually our biggest problem is keeping the poachers out. These channels are about 2 feet wide, 2 feet deep, and about 50 feet long; and we've got ten of them. We stock them with anywhere from ten to 25 thousand fingerlengths each. For ten channels you're talking about 100,000 pounds of fish. Everything goes well, and it turns out they're more susceptible to disease at the warmer temperature, but we'll probably produce this year over there, before poachers get them, something like 60,000 pounds of fish. One channel, the one that's closest to the fence over there, we harvested the other day, and we took out fewer pounds of fish than we'd stocked it with. But they cut the fence, and we find in the other channels where the fishermen had tossed over the fence, and you find their lures.

KRESS: Are you actually selling the fish?

FALKENBERRY: What we're doing is cooperating with a commercial food process and again we're trying to work ourselves out of business. We want to get this technology going.

KRESS: You feed the catfish then?

FALKENBERRY: Yes. You can buy catfish food.

KRESS: I know people who do this and sell it on the open market.

DELEGATE: You have not been seriously considering having smaller localized power generating facilities and using the waste heat for local space-heating?

FALKENBERRY: Right. The reason is that on the economies of scale he was talking about the small power plants would just cost so much, that it would just ruin the cost of electricity.

DELEGATE: Well, the big advantage is at that point, you'd get 80 to 85% efficiency and even more if you're really good, but the increased efficiency is the added bonus.

FALKENBERRY: But the economic trade-off would just get you. Not only that, but if we moved a plant to downtown Chattanooga or downtown Knoxville, the people who have their home heating systems installed are not going to scrap them for that, so the only thing you can do is find a new development. Just like solar heat. We expect that the use of solar energy for home heating and maybe even home cooling will come along to some extent, but it's going to be on new homes. Now, there are a few people like me as a researcher, if my wife didn't divorce me, I'd probably go out and put a solar reflector on the roof.

KRESS: You have that problem too, eh?

FALKENBERRY: But for most people, they won't do it. So I think it's primarily in new construction. It's a tough economic barrier to break.

KRESS: Incidentally, we do that in our refineries. For instance, where we generate steam, we generate it at maybe 650 to 800 pounds. We use it at that pressure and level and then we drop it maybe to five hundred--then we drop it to 180 and then we drop it down to 60, and we even have a 15 pound system. We get that last drop out of it. That just makes common sense engineering; it's nothing magical.

DELEGATE: Do you grow catfish also?

KRESS: We haven't tried it, but I'm thinking seriously about it.

FALKENBERRY: You need to taste those grain fed catfish. They are delicious.

DELEGATE: Does TVA have any plans for nuclear-powered generating plants in this area?

FALKENBERRY: Yes. We made a determination in 1966 that nuclear plants had developed to the point that we could consider them as reliable power sources, and it was a matter of economics. We bought three units at Browns Ferry which is close to Huntsville, Alabama. These are three 1150 megawatt units. The first unit is just operating with an essentially full load now. But, we just started it in August. We're beginning fuel loading on the second one. Maybe by next summer, it'll be fully operational.

There's a third unit at Browns Ferry that's going to come along about a year after that. North of Chattanooga we've got two 1200 megawatt Westinghouse pressurized water units, and up the river at Watts Bar, which is about half-way between Chattanooga and Knoxville, we've got the 2 unit Wattsbar nuclear power plant which are also Westinghouse machines. They are essentially twins for the supportive units, and we've bought two pressurized water units from Babcock and Wilcox; it'll be installed down near Scottsborough, Alabama. We have tentatively selected a site not too far from Nashville in one of the Cumberland reservoirs for a 4-unit.

We've already bought the generators. It's just a matter of where we're going to put them. These are the ones to come in by 1982. That's four 1200 megawatts units and that ought to add up to 13 units and close to 22,000 megawatts of nuclear power and we are evaluating bids now for four to six more to come in, and we don't have a home for them yet; we don't know where we're going to put those units needed for 1983-89.

DELEGATE: But, you all haven't gone after contracts for, like, General Atomics' HTGR's that work at forty percent efficiency or something like that.

FALKENBERRY: Right. The bids that we're evaluating right now include the

GAHDGR's. I don't know who's going to get the business.

DELEGATE: What types of research is the Institute doing in the field of transmissions and distribution divisions?

FALKENBERRY: All they're looking at is the highest transmission voltages in use now which are five hundred thousand watts or volts or 500 kV. and some systems are experimentally going to 767 kV. in this country. What we're really looking at is probably the next reasonable step for TVA with our 500 kV. system and it will probably be the 1100 kV. system. For the people who own 767 kV. systems, probably the next step for them ought to be around say 1600 kV. So, EPRI is looking, I guess, at what we call ultra-high voltage--ac overhead--ac transmission, and also, the highest operation dc transmission line is, I think, 400 kV.

The Institute is looking at much higher dc transmission voltages. They are also looking at underground transmission. They're looking at the high capacity of more or less conventional oil-fueled pipe-type cables and then so-called resistive cryogenic conductors. Now this is not super-conductors. Cool it down to about liquid nitrogen temperatures and your resistance drops down to about a tenth of what it is at room temperatures. The other thing they're funding is the development of super-conductors for underground transmission. These operate at just a few degrees above absolute zero. If you had that technology right now, I'm not sure how many power systems would use it, and the reason is that for it to be useful at all, you've got to be talking about transmitting at least 5000 megawatts or maybe 10,000 megawatts of power on one line.

One reason you see as many overhead lines as you do, is because you need redundant circuits so that if one circuit goes out or one generator goes out, the lights stay on. I think TVA would probably be very reluctant to invest in effect 5000 or 10,000 megawatts of capacity in one underground conductor, particularly when it's serviced by mechanical equipment, refrigeration equipment and all that. When it went out, you just probably would not have the redundant current paths to meet your load. But as power systems grow, you saw these curves that he and I had. The time is coming when 5000 megawatts will be peanuts.

DELEGATE: Something else, have you all been doing any research as far as trying to improve the efficiency of the heat power cycle?

FALKENBERRY: Yes. That's really the reason for doing the work on the MHD. We're interested in fuel cells. In the case of fuel cells, you just say the heck with the heat power cycle, we'll convert potential energy to electrical energy.

DELEGATE: Convert directly over?

FALKENBERRY: Right. Take fluid combustion: One reason we're interested in that is that we should be able to operate that thing; that's about the only way that we know of to use coal as perverse as it is to generate the kind of temperature that it takes for a combined cycle, so that you get those higher efficiencies. The problem with the straight-steam cycle is the efficiencies begin to level out much above 1050 to 1100 Fahrenheit and Bull Run is about forty percent. You spend a lot of money for a small increment of additional efficiency.

DELEGATE: Do you all do any research in the field of land reclamation after tearing up and strip-mining? Do you all do anything in that?

FALKENBERRY: Yes. I think one of your field trips is on a TVA restored strip mine. For all practical purposes, we have to live with all the ash that we produce--5 million tons a year. During your field trip out at Bull Run Steam Plant ask them to take you for a look at the ash ponds there. You may be impressed.

FRADIN: You were talking about this problem of fly ash. What are you going to do with it? It seems to me it would be a fascinating study for a group of students to go out and identify all the different things you could do with fly ash. Maybe you could even go out and try and get certain people that might have a need for it that don't know about it. You could let them know about it.

ROLE OF THE BREEDER REACTOR IN U. S.
NUCLEAR POWER DEVELOPMENT

Peter S. Van Nort, General Manager
Project Management Corporation

INTRODUCTION

Since 1965, the growth in energy consumption in the United States has averaged about 4.5 percent annually. This trend is expected to continue for the foreseeable future, although the rate of growth may be reduced. Regardless of the precise rate of growth, the U.S. is faced with a substantial gap between the rate of energy consumption and the available supply of various domestic fuel reserves. Significantly, those fuels most in demand have the smallest domestic reserves. Oil and natural gas currently provide nearly 80 percent of all energy consumed in the United States, but they represent about 6 percent of our energy resources. At present rates of consumption, and even with major new discoveries, the U.S. reserves of these fuels may last no more than a decade or two into the next century.

While energy conservation can help to some degree--and should be aggressively pursued--it is unrealistic to expect that conservation measures alone will solve long-term energy problems. By the same token, there are serious economic and political risks to the U.S. that attend any significant reliance on foreign oil and gas supplies, even though additional imports offer some near-term relief.

The use of coal, the most abundant domestic fossil fuel resource, is becoming increasingly limited by environmental restraints. Substantial technological development is needed to reverse this trend. In addition, coal will grow in importance as a source of pipeline gas, lubricants, feedstocks for chemicals, and other non-fuel uses.

Uranium, on the other hand, holds even greater energy potential than coal. In fact, with the breeder reactor, U.S. uranium reserves should last for centuries instead of decades, and certainly until fusion or other more advanced systems are developed. Moreover, maximizing the use of uranium has important conservation implications. Uranium is essentially a single-purpose fuel. Unlike coal, it is of little use except as fuel for central station electric energy production.

Against this background of additional electrical-energy requirements, uncertain and increasingly costly oil and gas supplies, environmental problems, and growing priorities for the non-fuel use of coal, it seems clear that the only logical strategy for solving these problems is to expand the use of nuclear power for the production of electric energy.

Development of the breeder is critical to assuring adequate long-range supplies of nuclear fuel. This was the conclusion of the 1962 report to the President of the United States from the Congressional Joint Committee on Atomic Energy and subsequently a high priority was assigned to development of the liquid metal fast breeder reactor (LMFBR) concept. Even today, the breeder remains the only advanced central-station electrical generating technology that does not rely on fossil fuel, and that has the potential for attaining widespread commercial use within the next 15 to 20 years. Geothermal does appear to be feasible for central-station energy generation but has geographical limitations on its potential utilization in the U.S. Solar, wind, and other potential energy systems also show promise in meeting some needs, e.g., solar residential heating and cooling, but still have many unanswered questions about their other possible electrical-generating capabilities. Therefore, it is essential to have a high-confidence strategy aimed at providing for future energy needs. The breeder satisfies this requirement. Thus, while the U.S. should pursue a vigorous non-nuclear energy research and development program, with the breeder the U.S. will be assured of at least one option that can supply plentiful, clean power for centuries.

The breeder's major appeal is, of course, conservation of energy resources --an essential element in the pursuit of the U.S. energy self-sufficiency. With the breeder, there is a substantial increase in fuel utilization efficiency--the prospect of utilizing perhaps 60 percent or more of the energy in uranium instead of 1 or 2 percent used with current light-water reactors. The economic benefits of such increased efficiency are compelling. With this efficiency, the life of U.S. uranium supplies would be stretched from decades to centuries. Adequate supplies of nuclear fuel will help to stabilize energy costs.

The breeder also has a number of important environmental advantages. For example, it will achieve thermal efficiencies comparable to those characteristic of modern fossil-fueled plants, while retaining nuclear power's air quality advantages. The more efficient utilization of uranium in a breeder means only one-thirtieth as much disturbance in the mining of uranium ore compared with a light water reactor, and only one nine-hundredth as much as for the mining of coal to obtain the same electrical output. Development of the breeder will allow use of the substantial quantities of depleted uranium tailings from the weapons program and the manufacture of fuel for conventional nuclear power plants. These tailings alone contain energy sufficient to meet U.S. needs at present rates of consumption for at least another 200 years.

U.S. LIQUID METAL FAST BREEDER REACTOR (LMFBR)

Interest in the fast breeder dates back to Enrico Fermi's early concepts of a self-sustaining reactor, achievement of the first nuclear chain reactor at the University of Chicago, and the wartime Manhattan Project. Since then, much of the preliminary effort on the LMFBR has been conducted at the U.S. Atomic Energy Commission's national laboratories. An experimental reactor called Clementine at Los Alamos National Laboratory was used from 1946 to 1953 to demonstrate the feasibility of operating a reactor with fast unmoderated neutrons, plutonium fuel, and a liquid metal coolant.

The Experimental Breeder Reactor I (EBR-I)--which, incidentally, produced the first nuclear-generated electric power--was built and operated by Argonne National Laboratory from August 1951 through December 1963 to confirm the breeding principle in a fast neutron reactor and to establish the engineering feasibility of using a liquid metal coolant. This experience along with other early liquid metal-cooled experimental reactors contributed important information to reactor design and safety. These reactors included the Sodium Reactor Experiment, the Hallam Nuclear Power Facility, and the Submarine Intermediate Reactors Mark A and B.

In the mid-1950's construction began in the U.S. on two fast reactor electric generating facilities--the 62.5 megawatt thermal (MWt) Experimental Breeder Reactor II, and the 200 MWt Fermi reactor. EBR-II has operated successfully for more than 10 years, producing over 1/2 billion kilowatthours of electricity and clearly confirming the feasibility of breeder power plants. Today, as an experimental plant, it continues to show breeders to be technically feasible, clean, and reliable producers of electricity. The Fermi reactor, now decommissioned, achieved criticality in 1963 and produced 32 million kilowatthours of electricity before the project was terminated in 1972. This reactor provided important technology as well as operating and maintenance experience useful to future LMFBR power plants.

In the mid-1960's construction was initiated on the 20 MWt Southwest Experimental Fast Oxide Reactor (SEFOR) facility which was a joint U.S./Federal Republic of Germany effort directed at providing a facility to conduct research on the safety of LMFBRs. The SEFOR program was concluded early in 1972 after successfully confirming the safety character of mixed oxide fuels for LMFBRs.

In July of 1969, the U.S. Congress, through Public Law 91-44, authorized the AEC to begin on a two-phase approach for the United States' first large-scale LMFBR demonstration plant. The purpose of the first phase was to define the technical and economic characteristics of the plant. Atomics International, General Electric, Westinghouse, and U.S. electric utilities participated in this effort. Public Law 91-273, enacted by Congress in June 1970, authorized the AEC to undertake a second phase--design, construction, and operation of a demonstration plant.

It became apparent by early 1971 that the logical next step in the LMFBR development program should be demonstration of the breeder concept in a large electric generating facility operated as an integral part of an electric utility system. With the experience of 25 years of research and development, the time had come to scale up the LMFBR concept in terms of size and performance as a major step toward the ultimate goal of commercially competitive breeder reactor power plants. A solid basis for licensability and environmental compatibility had to be confirmed. Plant design, as well as operating procedures for such a plant, was urgently needed.

Attainment of these objectives required broad support from the American electric utility industry. To obtain counsel on how to secure general support, the AEC established two committees in April 1971--the Senior Utility Steering Committee and the Senior Utility Technical Advisory Panel. These committees consisted of senior management and engineering executives from the utility industry.

In his June 1971 Energy Message to Congress, the President of the United States called the breeder reactor the Nation's "best hope" for long-term supplies of clean and economical energy, urging a joint industry-government effort to demonstrate the economic potential of the concept by 1980. That same month, the Electric Research Council issued the Research and Development Goals Task Force Report. This report--containing current thinking on where the utility industry should apply research dollars through the end of the century--placed development of a commercially feasible breeder reactor at the top of the research-and-development priority list and identified a large-scale demonstration plant as the logical next step.

A growing number of independent appraisals by the U.S. government, scientific leaders, and industry groups since the JCAE report of 1962 had also concluded that the liquid metal fast breeder reactor should be developed at the earliest possible date. In response to this growing consensus, the U.S. Congress, nuclear industry, and electric utilities throughout the country endorsed the President's message; and in August 1971, Congress enacted legislation providing $100 million of direct assistance toward the project together with supporting research-and-development funding of up to 50 percent of the estimated capital cost of a proposed, large-scale demonstration breeder nuclear power plant.

Meanwhile, the President's suggestion that government and industry work together on the breeder demonstration plant was drawing positive responses from industry. Before the end of 1971, the U.S. Atomic Energy Commission requested and received a number of suggestions for cooperative arrangements. In early

1972, the joint proposal submitted by Commonwealth Edison Company of Chicago and the Tennessee Valley Authority was selected by the AEC as the basis for negotiation of a definitive arrangement.

In March 1972, two new corporations--Project Management Corporation (PMC) and the Breeder Reactor Corporation (BRC)--were created to implement a broad cooperative agreement unprecedented in the history of the Nation's electric power industry. Agreeing to combine resources through PMC and BRC were the U.S. Atomic Energy Commission and some 700 private, public cooperative, municipal electric systems throughout the country. The project was enthusiastically endorsed by the Edison Electric Institute, the American Public Power Association, and the National Rural Electric Cooperative Association. The total financial assistance pledged by the industry--more than $253 million--is the largest total every committed for a single energy research-and-development project.

THE CLINCH RIVER BREEDER REACTOR PROJECT

Project Goals. The Clinch River project, named for the plant's site near a river in Tennessee, is the key to successful transition from the AEC's 25-year technology development effort to large-scale commercial LMFBR source plants. The demonstration plant program was established with the principal objectives of demonstrating that an LMFBR can be licensed and operated reliably and safely in a utility environment and to confirm the potential economics of the fast breeder system. Other objectives of the project include, (1) verification of capability and key characteristics of fast breeder power plants for utility system operation, while simultaneously providing a broad base of experience and generating important information relevant to large commercial plant operation; (2) development, collection, evaluation and communication of important technological and economic data regarding LMFBR plant performance for the benefit of the public, government and industry; (3) demonstration of both the environmental desirability and high potential value of the LMFBR as an economical and practical near-future option for generating electric power; and (4) substantiation of the value of the LMFBR for conserving non-renewable uranium resources.

Basic Design Parameters. The Clinch River Breeder Reactor Plant will be a 380 megawatt electrical (MWe) sodium-cooled, fast neutron reactor that is fueled with a mixture of plutonium and uranium oxides. The general plant design is now complete and the cost estimates nearly finished. As with any first-of-a-kind plant, the cost will be greater than for a commercial generating station of the same size, but viewed in the context of the total program it will not be excessive.

The plant will be an integrated electric generation facility, designed to operate as a part of the TVA power-distribution network. The major components will include: a reactor and steam supply system; steam-turbine-driven electric generation system; cooling towers; electrical switchyard; and related auxiliaries and support facilities.

Designed for a 30-year plant life, the plant: (a) is being engineered to meet utility requirements for reliability, inspectability, and maintenance; (b) will have an initial breeding ratio of approximately 1.2 with the prospect of increasing this to 1.3 later on; (c) will have minimum environmental impact, including minimal planned releases of radioactivity from routine plant operation and a closed cycle evaporative cooling system; and (d) will provide full built-in safety features for protecting the public health and safety.

Principal Parties. The principal parties in the Clinch River Project and their respective roles are:

* PROJECT MANAGEMENT CORPORATION (PMC), the nonprofit corporation organized to manage the design, construction, and testing, of the demonstration plant. PMC has the responsibility for ensuring that project resources available

are effectively utilized. PMC has the lead role for overall integration of the plant design and construction work, technical supervision and contract administration of all activities including such items as overall schedules, project budgets and quality assurance. The PMC Board of Directors is comprised of five members: two Commonwealth Edison representatives, two TVA representatives and one Breeder Reactor Corporation representative. A three-man Project Steering Committee oversees the project on behalf of PMC.

* BREEDER REACTOR CORPORATION (BRC), a second nonprofit corporation created in 1972, provides senior utility counsel, disseminates information on project progress to the utilities and the general public, arranges for participation of utility employees in the demonstration phase of the program, and provides a continuing industry review of PMC's operations. BRC also coordinates the electric utility industry's financial contributions to the project.

* COMMONWEALTH EDISON COMPANY AND THE TENNESSEE VALLEY AUTHORITY (TVA), jointly submitted the basic proposal for cooperative arrangements between industry and government. TVA and Commonwealth Edison are providing the project with experienced management and utility operating background. Both organizations represent the utility community's interests by assuring that the design and operating features of the plant properly factor in the pertinent technical and economic requirements for operating a fast breeder generating plant on a utility system. Commonwealth Edison is providing the engineering management and procurement service to PMC, while TVA will provide management to oversee the construction and quality assurance activities for the Clinch River plant. TVA will own and operate the plant. Later, at the conclusion of the demonstration period, TVA will have the option of retaining ownership of the plant at a price based on its value to TVA, and to continue operation of it as part of its electrical generation facilities.

* THE U.S. ATOMIC ENERGY COMMISSION (AEC), plans and administers the U.S. government's overall nuclear research-and-development program, including the breeder reactor. As part of that overall responsibility, the AEC is preparing the Environmental Impact Statement which addresses the probable environmental consequences of the LMFBR if introduced on the broad commercial scale required to help meet U.S. energy needs. In addition, for the total LMFBR effort, the AEC develops and manages related base program research-and-development efforts. For the demonstration project, AEC provides major funding support and has the lead role responsibility for the design and construction of the nuclear steam supply system. The AEC makes available to the project the special expertise of its staff, laboratories, and contractors, and provides technical supervision and administration of "nuclear island" aspects of the Westinghouse activities.

Key Contracts. The project is organized under three major contracts: first, the primary contract among AEC, Commonwealth Edison, TVA, and PMC (which specifies principal arrangements concerning the design, construction, testing, and operation of the Clinch River plant); and second, separate agreements of BRC, representing the electric utility industry, with PMC and AEC, respectively.

PMC, in turn, has entered into prime contracts for project design services with Westinghouse Electric Corporation, as lead reactor manufacturer; and with Burns & Roe, Inc., for architect-engineering services. Holmes and Narver also provides services as a subcontractor to Burns & Roe.

As the lead reactor manufacturer, Westinghouse is developing the overall design and will provide the nuclear steam supply system for the nuclear portion of the breeder plant. As subcontractors to Westinghouse, General Electric Company (GE) and the Atomics International Division (AI) of Rockwell International Corporation are expected to provide major assistance and take lead responsibilities for respective portions of the project. The substantial participation of AI and GE is in keeping with one of the objectives of the LMFBR demonstration plant program; that of developing competitive U.S. industrial capability to reliably and economically fabricate the unique reactor components, and to design and construct a complete fast breeder plant.

Assignments of responsibility (see table for more detail) have been made along with the following broad lines:

- WESTINGHOUSE. Overall nuclear steam supply system, reactor system and primary heat transport system.
- GENERAL ELECTRIC. Intermediate heat transport system and steam generator systems.
- ATOMICS INTERNATIONAL. Fuel handling system, maintenance, and auxiliary systems.

DEFINITION OF RESPONSIBILITIES FOR THE NUCLEAR ISLAND

Westinghouse

- Overall integration
- Reactor and reactor enclosure systems
- Primary sodium heat transport system
- Containment structure
- Reactor support buildings
- Related control and instrumentation systems
- Overall plant control system

General Electric

- Intermediate sodium heat transport system
- Steam generator building
- Steam generator system
- SG auxiliary heat removal system
- Related control and instrumentation systems
- Piping and equipment electrical heating control system

Atomics International

- Reactor service building
- Sodium purification system
- Auxiliary liquid metal handling and service systems
- Radioactive waste disposal system
- Containment inerting and fire protection systems
- Liquid metal leak detection systems
- Reactor plant maintenance systems
- Fuel handling and reactor refueling systems
- Related control and instrumentation systems

Burns and Roe

- Building electrical power and emergency power systems
- Plant service building
- Heating, ventilation, cooling, and air conditioning
- Related control and instrumentation systems
- Radiation monitoring

Site. The Clinch River plant will be located on a 1,364-acre Tennessee Valley Authority (TVA) site on the Clinch River, adjacent to the United States Atomic Energy Commission's Oak Ridge Operations reservation. Mid-town Oak Ridge, Tennessee, with a population of about 30,000, lies about 12 miles northeast of the site, with most of this population residing at least 10 miles from the plant site. Within 50 miles of the site is metropolitan Knoxville, with approximately 178,000 inhabitants. The Clinch River site and the proximity of Oak Ridge offer good road, rail, and water access, and the convenience of existing nearby TVA power transmission lines. A preliminary site review by the AEC and followup studies by TVA-PMC indicate that this location is suitable from a licensing standpoint.

Extensive Clinch River site investigations and evaluations are underway.

Preparation of safety evaluation and environmental impact documents required for the Atomic Energy Commission (AEC) licensing reviews began in late 1972 and are now in an advanced stage of preparation.

Detailed site studies and site improvement and facilities planning have included the following activities: (1) completion of a topographic map of the area; (2) core drillings over considerable acreage with the plant site; (3) a historical and archaeological survey; (4) studies to analyze flood, tornado, and seismic activity potential; (5) erection of a temporary meteorology tower to monitor atmospheric conditions and establish baseline information against which to compare air quality when the plant is operating; (6) formulation of plans for such site improvements as access roads, railroads, drainage control; and (7) preparation of overall plant and site layouts.

Employment. During the first year of work on the site (1975), some 200 to 300 construction workers are expected to begin the grading and excavation with the number increasing as substructure work begins in 1976. A peak construction force of 1200 to 1500 workers will be building the plant during 1977-1981. A permanent staff of 110-125 will operate the plant in the 1980's.

When the construction phase gets underway, PMC, which presently has its main office in Chicago, will move to the Oak Ridge area. The engineering team will also include the following: 300 to 350 people each from Burns & Roe and Westinghouse; and 125 to 150 people each from General Electric and Atomics International.

Project Schedule. Initiation of the NSSS preliminary design effort included a number of program schedule-and-design reviews with participation from the AEC, PMC, B&R, and Westinghouse. During these reviews, which were completed this summer, the original PMC guidelines and objectives were re-examined in detail, a preliminary schedule was developed, and important design decisions for the NSSS were formulated.

The preliminary schedule resulting from these reviews adheres to the stated goal of the national LMFBR program, that of establishing a strong competitive breeder industry at the earliest practical date. The schedule shows start-up in 1982, followed by five years of demonstration on the TVA grid. The following table lists some of the key plant schedule objectives and major program event milestones.

TARGETED SCHEDULE OF PROJECT MAJOR MILESTONES

* Submit Environmental Report	October, 1974
* Submit Preliminary Safety Analysis Report	January, 1975
* Receipt of Limited Work Authorization (Start of authorized site activities)	September, 1975
* Receipt of Construction Permit	August, 1976
* Start construction of reactor containment building concrete mat	January, 1977
* Complete containment internal concrete to operating floor	January, 1979
* Set reactor pressure vessel	July, 1979
* Submission of Final Safety Analysis Report	February, 1980
* Start sodium load	November, 1980
* Receipt of Operating License	April, 1982
* Reactor Criticality	July, 1982

77

NATIONAL BASE-PROGRAM SUPPORT ACTIVITIES

To achieve the overall goal of developing the LMFBR into a commercial option for electrical energy at the earliest practical date, the U.S. Atomic Energy Commission has been proceeding along two essential and complementary lines--the LMFBR base technology program and the LMFBR demonstration plant program. The base program serves the demonstration program through the engineering, development, manufacturing, and prooftesting of components and systems. The central objective of the combined program is to develop a broad technological and engineering base with extensive utility and industrial involvement. Ultimately, these will lead to a strong and competitive commercial breeder industry.

Basic technology that is fundamental to the LMFBR concept is being developed in such areas as reactor fuels and materials, physics, components, and plant systems. Emphasis has been given to assuring that LMFBR components, systems, and related equipment will be designed, fabricated, inspected, and prooftested in such a manner that they will meet the required high level of reliability and safety under severe operating conditions. High priority also is being placed on assuring that the plant can be inspected and maintained easily.

One of the major facilities dedicated to the development of LMFBRs and the focus of current base-program efforts is the Fast Flux Test Facility (FFTF) now under construction at the AEC's Hanford (Washington) site. This facility, now scheduled for 1977 completion, will have greater capabilities for fast flux irradiation of LMFBR fuels and materials than any other test reactor in the world.

Presently, it is providing experience in the design and construction of LMFBR plants. FFTF also has been the focal point for the development of codes and standards that can serve the LMFBR industry. When completed, it will provide valuable operating and maintenance experience, and will be a training ground for personnel and industrial organizations and national laboratories.

The information gained will help provide the basis for developing the fuels, materials, and components necessary to realize the ultimate potential of commercial LMFBRs. The FFTF will complement and extend the experience of existing U.S. experimental and prooftesting facilities, among them Experimental Breeder Reactor II and the Liquid Metal Engineering Center, both of which will continue to have major roles in the LMFBR development program. EMR-II and its associated facilities at the National Reactor Testing Station in Idaho are providing important data on reactor core physics, safety, instrumentation, and components. EBR-II has been called the "workhorse" of the U.S. breeder development program because it is the only operating fast-flux irradiation facility for testing fuels and materials in the U.S.

The Liquid Metal Engineering Center, located in the Santa Susana Mountains close to Canoga Park, California, is a complex of facilities for testing and evaluating instrumentation and components such as heat exchangers, steam generators, valves, pumps, piping, flowmeters, and other mechanical elements for LMFBR plants. The test facilities include the sodium components test installation (SCTI), the sodium pump test facility (SPTF), the small components test loop (SCTL), and the component handling and cleaning facility (CHCF). The SCTI is used for testing sodium heated steam generators and heat exchangers under simulated nuclear powerplant operating conditions.

Through June 30, 1973 (FY 1973), the U.S. Atomic Energy Commission had spent approximately $1.4 billion on development of the liquid metal fast breeder reactor. AEC LMFBR expenditures scheduled for FY 74 and FY 75 are as follows:

	Operating Expenses (in millions)	
	FY 74	FY 75
Fast Flux Test Facility (FFTF)	$ 51.5	$ 64.6
Clinch River Breeder Reactor (CRBR) Development	10.7	45.4
Support Facilities	36.5	43.0
Engineering and Technology	94.5	101.5
Safety	26.2	36.7
CRBR Cooperative Demonstration Program - Direct Assistance	13.6	14.0
TOTAL	$233.0	$305.2

THE ROUTE TO COMMERCIAL BREEDERS

There is a good prospect that commercial scale liquid metal-cooled breeders can be developed to where they will produce kilowatthours at the bus bar competitively with alternative methods of generation. In fact, a large potential margin of economic benefit over cost has been identified for development of the breeder. Providing impetus for the LMFBR program is the realization that, as with any new technology, substantial lead time is required for development and subsequent implementation on a scale significant enough to influence the U.S. energy economy. By way of a measure, the light water reactor demonstration plant projects such as Dresden were begun in the mid-1950's; yet now, some 18 years later, nuclear power accounts for less than 6 percent of the country's electric energy production. Although, with today's advanced breeder technology, commercial development may be accomplished on a relatively shorter time scale, significant returns cannot be expected before the 1990's.

What comes after Clinch River? There are a number of options. One is to have the Clinch River plant followed by several near-commercial breeder plants, each with progressivley greater capacity. In determining the size and timing of each successive plant, a balance must be struck between scaling factors and technical risks. This parallels the approach used in developing large-scale coal-fired plants and light water reactors. The first of the plants succeeding Clinch River might well have a generating capability in the range of 1000 to 1500 megawatts, and the same basic conceptual design. However, it would have significant evolutionary improvements in performance and economics, together with major design simplification. An alternative approach would be to proceed with more intermediate-scale demonstration plants before building near commercials. This has the advantage of being a more conservative approach but at a considerable increase in program cost. These options are currently being reviewed to determine which is most desirable.

The principal technical obstacle to large plant construction at present is the lack of technological base for the design of large components, and the reluctance of equipment manufacturers to supply them on a warranty basis. A non-nuclear off-line testing capability which will accommodate full-size components and systems will help solve this problem. Further development of high-performance breeder fuels is also necessary and is being included in the AEC's stepped-up R&D program. These measures should speed up progress and hold down overall program cost. In addition, if the first option is chosen for implementation, design of a near-commercial breeder should be undertaken within the next year. Construction should begin as soon as financial arrangements can be made.

Although it will cost less per kilowatt than the Clinch River facility, the first near-commercial plant will still be expensive. Based on our 25 years of experience with light water reactors, we have every reason to believe that per kilowatt plant costs will come down with each successive increase in plant size. With the accumulation of successful breeder operating experience, we will achieve higher plant availability, and lower per kilowatt costs.

The British, French, and Russians all have aggressive R&D programs aimed at breeder development. There are several 250-megawatt class breeder plants now in operation overseas. The United States should take full advantage of foreign developments; but to place total reliance on overseas breeder technology as a substitute for continuing our own program would weaken our ability to achieve the goal of energy self-sufficiency. In addition, there is a crucial, "critical mass" of industrial and technological capabilities and skilled manpower that is an essential element of successfully implementing "high" technology. Whether these capabilities will be available to implement and modify a foreign breeder technology in a U.S. context--with different regulatory requirements--is a serious question that must be fully addressed. By proceeding with the breeder demonstration plant and base technology program as rapidly as possible, we can preserve the nuclear option for energy self-sufficiency and realize the benefits of this new energy conversion technology at the earliest practical date.

There are some who recommend abandoning or even retarding the U.S. LMFBR program on the speculation that uranium supplies will be more plentiful, that energy growth rates will not materialize, or even that some new technology will eliminate the need for the breeder. We believe this would be a serious policy mistake for the United States. Unfortunately, no major new uranium district has been discovered in the United States since the late 1950's, despite increased exploration activity.

Thus, if these speculations prove wrong, it would then be too late. If shelved now, the breeder could not be developed in time to avoid the serious energy supply problems which are bound to occur if we fail to make full use of nuclear power's potential.

Developing the breeder must be vigorously pursued. Abundant supplies of clean, economical, environmentally acceptable energy are essential to the U.S. economy, security, and standard of living. The costs will be high; but the potential benefits, demonstrated technical feasibility, and high probability of success warrant no less than a continued, top-priority commitment by both the U.S. Government and industry.

DISCUSSION

GEOPHYSICAL ENERGY RESOURCES
"Solar, Wind, Ocean and Geothermal"

Dr. Robert F. Cohen, Program Manager, Ocean Thermal Energy Conversion
National Science Foundation/RANN Solar Energy Program

Almost any simple statement on energy is an oversimplification, including my own remarks. Be cautious of what you read and what you hear. As you may have gathered from what you have already heard at this meeting, energy is a sophisticated and complicated subject. If I can do nothing else today, I would at least like to help bridge some of the gap between the popular perception of renewable energy sources and what in fact may be their true potential. The gap is rather wide, I think, because the media have not really helped us to understand what this potential might be.

The energy sources that I'm going to talk about are renewable sources, some of the alternative sources of energy that are available to us. Some people call these environmental sources or natural sources. Another term for them that I've invented is "geophysical energy resources," because they relate to natural processes associated with the earth. In other words, the solar energy options, plus geothermal energy. "Solar" in this context includes some of the indirect forms of solar that don't immediately strike one as being solar, but in fact, are. I'll try to give an overview of what these sources are; I'll try to get you calibrated on what their resource potential ultimately might be; and try to tell you to some extent how we're trying to develop these sources.

In the national energy program, the National Science Foundation (NSF) is currently the lead federal agency in both solar and geothermal. As far as my own particular activity, I'm mainly concerned with one facet of the solar program, ocean thermal, although I am conversant with the other fields. I'll emphasize the ocean-energy alternatives, which are the ones that I know best for having worked with them more closely.

At the moment, 99% of the energy we use is solar, 4% of which is renewable solar energy in the form of hydropower, plus about 1/2% from wood-burning and food production. We're all personally running on solar! We're drawing on our bank account of stored solar energy in the form of fossil fuels for 94% of our energy. At the moment, the other 1% of our energy is nuclear, and that percentage is increasing. We obviously have an opportunity to increase the proportion of renewable sources. Figure 1 (provided by A.D. Watt) will calibrate you on what these relative amounts are. It is a debatable subject just what the absolute amounts of these resources are. An area of one square inch on Figure 1 represents 100 Q. One Q is 10^{18} BTU, a tiny square here. It is estimated that the world would like to expend that much per year in the year 2000, of which the U.S. would be using about a sixth.

We are talking here about world reserves and not about resources. Reserves are resources estimated as available at a given time at the current value of those resources. Not how much is actually there, but how much is readily available at that price. So back in the late sixties, these were the estimates of those reserves: geothermal steam was estimated at 5 Q; oil shale reserves at 5 Q; natural gas at about 10 Q; oil was estimated at 10 Q; coal was estimated at 200 Q; uranium for use in light water reactors at 10 Q, of which 1 Q had been utilized for military applications. If the uranium were used instead as fuel for breeder reactors, one could magnify that amount of energy to 900 Q. What is mentally exciting is that if one could produce controlled nuclear fusion on earth, and if all the deuterium in the oceans were used, one would have 11 acres on the scale of Figure 1. That would really solve our energy problems, at least in principle.

We do know, however, that the sun has solved the fusion problem; we can tap a fusion machine already operating. What can be done with the fusion power? We are protected from its damaging effects--the bads--but can we derive some of the goods? The question is what can solar do? One year's supply: that is, the amount of sunlight (solar energy) hitting the earth in one year over the whole area of the earth amounts to about 30 square inches or 3000 Q in Figure 1. By intercepting and utilizing a small percentage of this flux there is enough energy to run the earth for the foreseeable future. You will probably live to see considerable realization of that. We hope so. We think that the solar energy options are minimally impacting. Thus the question is: what are the prospects for achieving such utilization to get us on a current banking account? That is, to use current solar energy income and maybe increase our stored solar energy rather than continue to deplete it. So, this is the challenge: what can we do to collect solar energy? One way is to let the earth do it for you, which one might call natural collection of solar energy, and the other is to introduce man-made devices, which can be referred to as technological collectors.

By the way, I think one popular fallacy or misconception-certainly among laymen in general-although you probably don't have this problem-is that there's a single solution to the energy problem. More likely is that we will develop a superposition of solutions and that each technology will contribute its own optimum amount of energy, an amount that will change from time to time.

Figure 2 shows many of the solar energy options. You can take your choice from the available solar options as to which are the more likely, more immediate, and more cost-competitive. The point is that we can get a contribution from many of these, and, of course, you're already familiar with solar energy as hydropower. Solar options do have their impact problems, with which you are familiar in the case of hydropower.

We are going to have a resurgence of wind energy applications, and that's now being carefully studied. We don't need to develop hydropower technology. Photosynthesis has been going on without us, but we can, in fact, improve on that to some extent as I'll try to explain. Another natural option is ocean thermal gradients.

The oceans act as a natural storage and collection device for sunlight. The warm surface waters, together with cold water from ocean depths, can be used to power a heat engine and to generate electricity.

There are other ocean energy possibilities, among which are tides. The layman typically has the misconception that if one talks about ocean energy, that that's tidal energy--period. Tidal is in fact probably one of the least plentiful forms of renewable ocean energy, and ocean thermal is the most plentiful one. Other possibilities are ocean currents (like the Florida Current) waves, and salinity gradients. Thus there are five different renewable ocean energy options.

In the technological collection of energy, one can supply man-made devices--person-made devices, if you will--that convert the sunlight into usable forms. One supplies the technological means for conversion, such as converting the sunlight into heat, otherwise known as photothermal conversion. One can do that at a high or low temperature. If one does it at a high temperature, then the heat can be used to run a turbine and that will provide electricity. Photothermal provides two options: using the heat as heat and using the heat to produce electricity. Finally, the so-called direct conversion of sunlight into electricity or photovoltaic conversion--that isn't the only way, incidentally, but perhaps it's the most likely method to succeed. If we knew how the electric eel did the job, we might have a better method.

That's just a brief overview of the solar options, including the six currently comprising in the U.S. solar energy program. The six program options are listed in Figure 3, which shows the evolution of funding. The six options were selected because each offered a likelihood of providing a cost-competitive source of substantial amount of energy, although each option presented risks and uncertainties.

The problems aren't purely technological, either; a quick technological fix isn't always possible in our society. Some institutional changes will also be needed to help introduce this new technology.

During the fiscal year just ended, there was funding for solar energy research of about 14 million dollars. Half was for heating and cooling for buildings, which is regarded as a relatively near-term application. This technology is rather well developed and second, building heating and cooling, including tap-water heating, consumes 25% of our total energy right now. It's potentially a big pay-off area and furthermore, the technology is not all that sophisticated, but it's still going to take awhile to perfect it. Wind energy is regarded as the next most immediate solar energy technology to be implemented. It's simply a resurgence you might say, of a technology we've already implemented in the thirties, before the Rural Electrification Administration (REA) put the windmills out of business, when they electrified the country.

For the current fiscal year, the administration has asked Congress for 50 million dollars for the U.S. solar energy program, compared to about 14 million last fiscal year. The internal allocation of this funding is between these six areas: (1) solar heating and cooling; (2) solar-thermal; (3) ocean-thermal; (4) photovoltaic; (5) bioconversion; and (6) wind energy. The heating & cooling allocation is about a third of the total. Are there any questions?

DELEGATE: Are you actually requesting 50 million dollars in this omnibus energy bill for the U.S. solar energy program for the current fiscal year?

COHEN: That has been requested by the Administration, by the Office of Management and Budget (OMB). The House passed it overwhelmingly. I think it's passed by the Senate.

DELEGATE: What is the total federal energy budget?

COHEN: About 2.2 billion dollars. This is 50 million out of 2.2 billion, I believe, out of 2200 million. A lot of things asked under the name of energy in that bill may not be technically energy, so it's a good question what the total really is.

DELEGATE: Where is most of the research going on?

COHEN: The research group can be a team that includes universities and/or industries and/or government labs, or can be any one of those. RANN tends to fund the best performer.

DELEGATE: Where is it going?

COHEN: I don't really have a good breakdown on that. I think you can get that from a summary of awards that we've made. A lot of them are increasingly to industry. I think it's about half industry and half universities. It varies quite a bit among the programs. The more exploratory research tends to be done by universities. The more hardware-oriented research is done by industry.

DELEGATE: How do you become eligible to receive funds from NSF?

COHEN: I guess the basic eligibility is interest, competence, some experience, and then coming in with something that will help us attain in some small or large way the program goals, whatever they might be in each case. So, it's goal-oriented research, rather than basic research. It's really one small step or one large step toward those goals that each award is supposed to accomplish.

FRADIN: In the last issue of FASST News, there was a little box in there, regarding NSF/RANN materials. You can, when you join FASST, send in that material request form, check a little box, and we'll send a card back to you. On this card, you check off areas that you'd like to get information from the NSF. One of those things could be a guide to programs, and they have a nice thick little book which explains how to submit proposals, and that kind of thing, in any of the areas the NSF supports.

COHEN: It's called, Guidelines for Proposals. I've got a copy in my briefcase if anybody wants to look at it.

FRADIN Contact us, and we can get you one of these little cards, mail it into RANN, and they'll put you on the mailing list.

DELEGATE: How is the NSF/RANN project research different from projects funded by the Atomic Energy Commission (AEC)? Here we've been talking about how different research has been funded. I just wondered how much and what type of duplication there is. Are there distinct differences on the types of programs that are funded by AEC, for example, and by the NSF or what?

COHEN: Well, actually the emphasis is quite a bit different. We're largely funding solar.

DELEGATE: But RANN involves other things other than solar energy, right? At my university, there's a RANN cadmium project and the AEC Oak Ridge National Laboratory also has a cadmium project. AEC might have solar energy, and the NSF might have solar energy...

COHEN: There's not very much overlap.

DELEGATE: O.K.

COHEN: Last year in solar energy, the AEC spent $600,000 for solar energy research. So, NSF provides most of the support in the solar energy area at the moment. In geothermal, although NSF/RANN is the lead agency, there are also two other agencies that have quite a lot of the action, the AEC and the Department of the Interior.

DELEGATE: Do you happen to know how many individuals and researchers are funded by the NSF for solar energy?

COHEN: It's changing rapidly. I don't have the numbers handy. We have a list of awards for fiscal '74 and one for fiscal '73. Each project is listed. You can get the complete story by asking me to send you that, but there are, I think, maybe ten, twenty, thirty awards or more in each of these six program areas. I hesitate to guess, probably over a hundred.

Let's talk now about some of the technologies. The heating and cooling option maybe bores you because you've probably heard a lot about it. The media are getting more interested in that now. Some people do have solar heated houses, and they're getting to be standard to write up in the paper now.

Solar-thermal conversion is simply the so-called greenhouse effect. You may be familiar with this, where you just let the sunlight come through a glass plate and then strike an absorbing surface. The infra-red or the heat energy that's then formed is trapped by the glass, which doesn't allow it to go back out. You end up inside the enclosure with temperatures approaching the boiling point of water very simply this way. The question is how simply and how economically can you warm air or water this way?

The basic collector concept is shown in Figure 4. Mounted on a roof is an assembly which requires a glass cover plate or two, an absorbing surface, and an insulated area. One can circulate water through tubing so that water is warned by the spectrum of the light that is coming in through the glass. Infra-red or heat energy is formed, and the plate gets real warm. The heat cannot readily escape, and most of it is trapped in the enclosure and goes to warm the water in the tubes; one can also warm and circulate air; i.e., the working fluid would be water or air. One simply circulates that working fluid first into a storage device (see Fig. 5). In the case of air, it would be typically just a pile of rocks; for water, a storage tank.

In one house in Denver, there are two beautiful columns which are cylindrical cardboard forms which are painted red. They look nice, and are filled with rocks. Warm air is circulated, warming the rocks. Then, whenever heating air is needed, the air is circulated through the rocks in through the heating system, if it's a hot air system. Warm water, in turn, can be stored in a storage tank of water; and other means of storage are now being looked at, such as the heat of fusion of various materials like wax. Heat can be stored in various ways, but at the moment, water or rocks seem most economical.

The solar radiation is typically collected on a south facing roof or a south facing wall. When sunlight isn't available and there isn't enough thermal energy in storage, one would use an auxiliary supply of heat. Thus, one wouldn't typically design a system to rely exclusively on solar energy. This system could be used both to cool the house in summer and to warm it in winter, and to warm the tap water: all three applications. The more of the year for which this is done, the greater the time in which to amortize the investment and the more worthwhile is the investment. It can be used even on cloudy days in many localities because it doesn't require direct sunlight. It can use diffuse sunlight although performance is better when more sunlight penetrates the atmosphere.

So much for that story. Now, let's hear about one application of that. In Florida and California, but mainly in Japan and in Israel and in countries like New Zealand and Australia, they have been using this solar energy for some years. Hundreds of thousands of systems were purchased for tap water heating in Japan. The device sold in Japan has a unit the size of a bed spring mounted on the roof with a water tank above. It is enough for a typical Japanese family. It used to be largely the rural people that would buy these, to get their daily bath. It isn't a big capacity system, but it costs about a hundred dollars worth of yen to install.

These units don't look particularly aesthetic on a beautiful Japanese roof. I think a lot of these systems can be built into houses, especially new housing, to make it aesthetically satisfactory. I think there has been some backfire with this technology in Japan, and I think it can backfire here, too. In fact, it has backfired in Israel; I know there it looks like a mess because everybody sticks up these devices on the roofs of apartment buildings typically helter-skelter, and they look like a bunch of TV antennas. One of the problems is that new technology can backfire, and I think solar tap-water heating has backfired in Japan.

I don't quite know all the factors involved, but as the Japanese farmers got electricity and other fossil potential, they went off solar heating. Because the collectors required periodic servicing, they took more repairing than would have been desirable. They weren't as durable as they should have been. They were up on the roof, to boot. They began to abandon these; sales reached 3 or 4 hundred thousand a year, and then began to taper off. So, there is a problem with new technologies; they have to be properly implemented. This whole question of solar heating and cooling for buildings is beset with institutional factors. It's not simply a technological problem.

There's a film you can get from the National Science Foundation that shows several school solar-heating projects. Four high schools around the country are experimenting with these proof-of-concept experiments. Figure 6 is a picture of a building at M. I. T. that was built aesthetically, with the solar reflectors in the south-facing wall. You can build these things into buildings, and retrofit the buildings also; but not necessarily as satisfactorily. You can make solar collectors look pleasing. There are a lot of heating and cooling projects going on. You can get more information on that from the Foundation; and you could borrow that film.

If this solar heating and cooling is so attractive, why hasn't it been done already? Well, for one thing, the research hasn't been done to optimize the technology, but on the other hand, that could have happened independently of the government, but it hasn't happened. As in all these technologies that we're talking about today, the reason it hasn't happened is because the fossil fuel energy which we were competing against (stored solar energy) was too cheap and relatively attractive. Ironically, solar energy was fighting against itself, as it were. So, the economics of this is a key item. I don't mean to say it's pure economics, but that it's a key item. That's one reason it hasn't happened. Figure 7 shows some relevant costs.

Of course, one of our problems, too, is that natural gas had become plentiful and all too cheap. Now we're going to suffer from that. Gas prices vary geographically, but gradually have been going up in price. Gas is still a bargain compared to fuel oil, however. That's the remarkable thing: here's a quality fuel cheaper than oil, which is not as attractive; now there is some tendency for the curves to cross over, and gas is becoming priced comparably to oil when you can get it; and when you can't get it, the price becomes infinite.

Solar heating is already competitive in some localities with electric resistive heating; I should editorialize at this point: I remember the guy who says the only less efficient way of heating a house than with electric resistive heating is to burn the house; but you can see that manifested in the price of electricity. It's an absolutely ridiculous thing price-wise and the reason, of course, that it's expensive is because you only use a third of the energy you started with, and there's also some profit in transmission involved. You end up with 30% of the energy at the place you use it. It's a very nice form of energy. Nobody questions that, but what have you accomplished?

What we really should be comparing here is with the costs of using electricity through heat pumps. That would make the cost of using electricity much more attractive, since the efficiency of conversion would be much greater. One would effectively get back some of the rejected heat that we had lost at the factory. Right now, what we're really comparing is the proliferation of electric-resistive heating and what the competitive cost might be for heating it with solar devices.

Solar energy costs something, basically the amortized cost of the installation and the maintenance cost. The fuel is free, but the system is capital intensive. Comparing that cost with existing energy prices, solar heating could be considerably cheaper than electric-resistive heating in many areas of the country.

Solar heating and cooling begin to be competitive with fuel oil and natural gas in many geographical areas although there are certain disadvantages that we've touched upon already. If we could, in fact, bring down the cost of solar heating and cooling systems by mass-producing them and making a durable product, then the hope would be that we can end up with a range of costs. Meanwhile we're becoming more and more competitive with other means (which are not necessarily available) such as natural gas.

There could be incentives introduced. One can't get natural gas in Colorado, for example, in a new installation. There could be an incentive if natural gas could be installed only in buildings where it would provide a backup for a solar heating and cooling system. This is one institutional option that can be explored by society. However, solar heating and cooling isn't going to come into being just because it is cost-competitive.

A related technology is the photo-thermal conversion at higher temperatures, leading to the production of electricity. Converting sunlight to heat at higher temperatures is trickier. Selective surfaces that are more sophisticated are needed to do this job properly. This is why it's further downstream, but it can be done and the question again is economics: when will it be competitive? What can we do about the technology to make it more attractive and make it more competitive?

Various people have various schemes. This has tended to capture the imagination of the press. You may have heard about the so-called solar farms. You could start with a desert area and introduce some shading and capability of irrigation. In principle, you can do the conversion by using flat plate collectors with a sufficiently clever design. Some concentration or focusing will probably be needed, and one way of doing this is with a cylindrical trough with a heat pipe of some sort in its focus. Basically, a working fluid is circulated through that pipe and gets good and hot. That working fluid is used to drive a turbine; that is, it is run into a power plant. No fuel is needed. Normally, we heat steam in a power plant with coal or oil. In this case, the sun does the heating of the working fluid.

There's another way of doing this. In fact, there's a nice demonstration of it in France (see Fig. 8) what is known as a point focus, where you have a tower basically. Instead of collecting the energy in a line, you really focus it at a single point to a parabolic reflector or you could do it with a lot of small mirrors that constitute portions of the parabolic surface. The French are doing this, and it is the so-called "power-tower" approach, used to achieve the solar furnace shown in figure 8 .

We're pursuing solar thermal technology using both the power tower and the line concentrator concepts. The solar furnace is a case where solar is really sort of indispensable. For certain industrial applications, extremely high temperatures are needed, so the French built this solar furnace. A thousand kilowatts of solar energy (one megawatt) is being collected in this device.

Temperatures of about 5000 degrees Fahrenheit are produced when the sun is available, which isn't always. This is in the Pyrenees. When direct sunlight is available, during much of the time, the solar furnace is used for industrial application and experimentation, etc., where they need these high temperatures. Here's a case where solar is fairly unique. There aren't many ways of obtaining those temperatures as readily. Do you have any questions at this point?

DELEGATE: How efficient is a system like this?

COHEN: It depends on the temperature differences, just as any thermodynamic cycle depends on the temperatures. The temperatures of the heat source and of the heat sink determine the Carnot efficiency. That's the highest theoretical efficiency you might attain. Then you have to discount that by the losses here and there. Basically, they are hoping to attain 20% or maybe 30% net efficiency, but they are also planning to utilize the rejected heat.

DELEGATE: Can you really get temperatures that high to run a turbo-generator?

COHEN: That's a good question. We'll find that out; we may have to have a hybrid system using existing turbines. We may have to warm the steam up a little bit more than you'd be able to do with just solar. This could use a hybrid of fossil fuel and solar heating.

Another solar energy program is research on photovoltaics. You've seen how satellites are powered. Maybe you've seen those little cells; I didn't bring one. They are largely used as the sources of energy for satallites because NASA can afford them for space applications. They work beautifully. They're great gadgets. They don't require direct sunlight, although they work better when they have it. The problem is that their price is too high for most civilian applications. That doesn't mean to say that they couldn't foreseeably be made at a lower price. You can buy these gadgets at what amounts to 20 or 30 dollars per peak watt. Twenty or thirty dollars a peak watt means 30,000 dollars per peak kilowatt. That isn't a competitive cost except for certain specialized applications like the spacecraft.

It's hoped that the cost can be brought down in the near future. Soon they expect to bring the cost of photovoltaics down by a factor of ten, and part of the goal of the technology research program in photovoltaics is to bring the price down by a factor of a hundred or more. There are some promising technical development there. There is a lot of commercial enthusiasm now. There are some single crystals of silicon being formed out of a melt that have 10% conversion efficiency. Mass production economies and intermediate markets for photovoltaics will help bring their cost down.

Are there any questions?

DELEGATE: What kind of temperatures have you achieved with flat solar reflectors with the black metal plates?

COHEN: They're trying to make the systems work at 180 degrees F, typically. That's the building application, not the conversion to electricity which requires much higher temperatures.

DELEGATE: You could also say the temperature is the same, but they have less efficiency.

COHEN: That's right. You lose efficiency. They can produce temperatures like that at about 50% efficiency. As you go up in temperature, you tend to go down in efficiency.

DELEGATE: What exactly is the number of watts that sunlight provides per square foot, I've heard estimates that the number is from 17 to 18 watts per square foot way up to 155 watts per square foot?

COHEN: The radiation of course, goes down to zero at night. By day it's about a thousand watts per square meter, which means a thousand watts per ten square feet (you have to kind of take an average). That is, 100 watts per square foot at noon on clear days, and it varies with the sun's zenith angle. If one tracks the sun, one can get that all day long. Then you lose it, of course, before sunrise and after sunset. You can average it over a year and maybe come up with a better number--a lot less than a thousand watts per square meter.

DELEGATE: Has the NSF been doing work with the use of silicon collectors like the guy in Arizona did? You'd put a piece of silicon over something like a sheet of metal; and since the silicon is like transparent infra-red, you would not have as much reflective loss (something like this).

COHEN: Silicon is a prime material for photovoltaics; let's put it that way.

DELEGATE: He was using it for a thermo-electric voltaic cell.

COHEN: I think what you're really touching on is the fact that there's a lot in common between the selective surfaces and the photovoltaic devices. Converting the heat into electricity has some solid state physics in common.

DELEGATE: What kind of operating costs are we talking about for solar collectors including problems of maintenance?

COHEN: The photovoltaics probably have a very low maintenance problem, and the durability of thermal collectors depends on how well they are engineered. What I'm really afraid of is people will start marketing shoddy stuff that requires a lot of servicing. In principle, it doesn't have to require a lot of servicing. If it is made out of plastic, one might have problems such as the Japanese do. If the cover plates are glass, we don't think there'll be much servicing if the system is put together right.

DELEGATE: What are you shooting for, twice a year?

COHEN: Well, again it's a trade-off question that's hard to answer very simply. I think the cost of maintenance has to be built into the initial investment, and one really has to say what he is willing to pay for durability. That question permeates our whole society. We're getting goods that are not durable. They tend to need a lot of servicing and to be replaced all too often.

DELEGATE: I may be talking about the same thing. I'm not really sure because I'm not that familiar with the photo-electric effect; but have they done any work with thermo-electric effect?

COHEN: Yes. As a matter of fact, you've hit on something that sort of falls between the cracks of what I've talked about. I was struck by that same point when a delegation of four Russians visited us a month ago. They're doing a lot of work on solar energy in Russia. In fact, that work includes thermo-electric effects, and that's why I said at the outset that it wasn't simply photovoltaics alone. However, our program is emphasizing photovoltaics, while the Russians are looking at both.

DELEGATE: Just from some things that I had seen, it seemed that the thermo-electronics had a lot of potential because if you make your collector; well, even after the sun comes down, if it's efficient at all, you're going to hold that heat part of the night.

COHEN: I think you're right. The economics look attractive,

DELEGATE: I was just curious to see if it's going to work.

COHEN: The answer is people in various industries have studied thermal electricity, not for this application, but we know something about it; but as far as the solar program is concerned, that could use more emphasis; that's my personal opinion. Certainly the Russians are giving it comparable emphasis to photovoltaics. Don't believe because we have these six program areas that we are covering all our bets. There could be other areas, but one doesn't want to fragment the program too much. One can't look at everything, but now we have a chance to open up new options.

There are applications other than satellites where expensive photovoltaics might be usable. Remote locations where there's no electrification and where Diesel generators are expensive are one example. When it's a nuisance to bring in fuel, one can consider a power system based on photovoltaics.

The Coast Guard is now investing in the powering of ocean buoys using photovoltaics. They store the energy in batteries. They were using only batteries to begin with, but they had to go out and replace them and service them quite a bit; and that was expensive. So, they chose to keep using batteries but charge them with solar photovoltaics. For remote applications, the cost and convenience factors outweigh each other. Hopefully, there will come a more intermediate market, as applications like this grow, that will tend to lead us more toward mass production of these things. That brings in economics, as you know. We need to increase this intermediate market. The technology isn't the only thing. We need to find a market for the technology in the near term to hasten the day when these become competitive for many applications such as we envision.

Another area you're also familiar with from one standpoint is photosynthesis. We have a program which is known as bioconversion to fuels. Re-thinking this photosynthesis from the standpoint of producing fuels, or, if you wish, hastening the fossil fuel production process. (see fig. 9) In fact, this country was half-powered by wood in the last century. Half of the energy came from wood-burning, and many people have advocated going to an energy plantation where we could grow crops for their energy value. This is really what the bioconversion program is at the Foundation, which is to produce the crops. You would still extract their food value initially, but you would degrade them to energy in the final analysis. So, bioconversion to fuel, which includes converting existing organic wastes to fuels in order to use them as fuels, is part of the program. Essentially, we have gone through a rapid fossil fuel production in which solid, liquid, and gaseous fuels were produced.

Shortly, I will talk about mariculture explicitly in connection with the ocean energy options, especially. There are many options that will end up deriving gaseous, solids, and liquid fuels; and this has a rather large potential. The question again is what is the cost of doing this? It isn't that we can't technologically do all these things. It's a question of at what cost can we do them? Any questions?

DELEGATE: Can you put a number on the Q value of solar farms? It seems large, but is it 1(Q) or 10(Q) or what?

COHEN: For example, right now we have a lot of large solar farms, otherwise known as "farms." The photo-conversion efficiency tends to be 1 or 2%. You can estimate that knowing what the flux is. This is potentially a great thing, but it has all kinds of questions attached to it, such as the need for irrigation waters, other resources, fertilizer, etc. I think there's hope in this program to increase the photo-conversion efficiency to work with crops that have a higher conversion efficiency. I think they're hoping to attain 4 or 5% rather than 1 or 2%. If one takes the cost of the daily market basket of food, by the way, it's an interesting calculation. One needs 3,000 kilo calories a day to survive. You convert that to the energy cost per million BTU. It's a simple conversion. It would cost you two dollars for those 3,000 kilo calories. That's almost $200 per million BTU. That's pretty expensive. Or maybe other fuels are inexpensive. Sugar is a lot less than that.

DELEGATE: What is the AEC solar energy budget for FY 1976?

COHEN: The AEC this year has twice as much funding as they did last year for solar energy. It's 1.2 million dollars, rather than .6 million dollars.

DELEGATE: I read an article which says that all the manure in the U.S. was under the fermentation process, and that they could produce 16% of all the natural gas in the U.S., besides all the fertilizer that could be used. Do you think that would be possible?

COHEN: I'd rather not comment on that. You have to analyze those statements, and you can do it as well as I can; or if you can't do it very well, we may be able to help.

Now, I'll talk about wind and geothermal and ocean energy. There is a fascinating book on the subject of wind energy called, Power from the Wind by Putnam. There was a fabulous windmill produced during World War II on Grandpa's Knob in the State of Vermont. This produced one-and-a-quarter megawatts of power. It was 50 meters tip to tip, just a big propeller. In other words, there was about a 175 foot span. Electrical energy produced was fed synchronously into a power line and it represented a real achievement.

I think it's largely attributable to the excess profit tax, by the way, that this thing was ever built during the War. They found they could write-off the investment. In fact, that's why it was never repaired, I understand, when the blade, which was undersigned, broke.

The wind program envisions a whole spectrum of windmills, a real resurgence of windmills. The emphasis of the NSF at the moment is to look at big ones. We don't quite know what the optimum size is. We do know that we'd like to attain one or two megawatt units that would look something like the one in figure 10. Also, there's a great potential for these regionally. It doesn't work well everywhere, but it's certainly viable in many places to have small windmills for given applications.

In certain pipe dreams, it's envisioned that by the year 2000 there could be half a million large windmills around the country regionally under an accelerated innovation plan. In other words, they're supposed to be generating energy something like the electrical power production in the country currently, if that implementation were ever achieved; that is, if there were proper federal incentives and if it were aesthetically satisfactory. The winds have a lot of potential that isn't being realized.

There is an unfair TV commercial (that I think they've stopped) that said, "what do you do when the wind stops blowing?" It showed the windmill rotating when the commercial began.

One can of course store the wind energy. One can also do something else, wnich is feed it into an electrical grid where one averages out the wind. If you had a windmill at your house, you could connect it into your own electrical power line. When you had wind, you could make the meter run backwards. Many meters would do just that. You would then get credit for what you put into the system, and the power company would save the electricity that it didn't have to generate. Everybody would be happy and that TV commercial would be insignificant.

There are other ways of storing. You could store the energy yourself. I don't think you'd want to do it in the form of heat, by the way. It would be a real mistake to degrade that high quality mechanical electrical energy into heat. You could run a heat pump, however, and store the heat you got from that. You could also run the individual windmills on transmission towers that we have already. You could redesign the transmission towers that are pumping electricity around so that they would house windmills. (see figure 11) In regions where the wind was right, you could just put them on existing redesigned towers and into a grid. You wouldn't really be changing the aesthetic situation that already exists. In principle, you can smooth out and store effectively by having networks of these things. So, there's a lot of potential in the wind, and as you noticed, the wind program is getting quite an increment of support this fiscal year basically because it's regarded as fairly immediate in application. A lot of the aerospace technology that we derived from World War II is going to be very useful in making these windmills more attractive from a technological standpoint.

Do you have questions?

DELEGATE: Has there been any thought given to putting windmill blades on existing towers and putting the energy directly into those power lines?

COHEN: I don't think you would necessarily put it directly in because you might have a transformer problem. You might string an extra wire. A windmill has a mechanical part that goes into a generator. Some of the windmills working currently such as out in Colorado are just pumping water, and you don't need a generator. You could have a reservoir above a town for example. You could use that to generate electricity. Windmills would be pumping up the water; then you just generate hydropower.

DELEGATE: Has the wind energy program found any environmental problems yet?

COHEN: Everything we do has an interaction with the environment. In this case, it's aesthetic, and I don't know if there are any other consequences that are significant ones. We have to come to grips with the problem and decide what the cost and benefits are. The environmentalists are going to have to decide what alternatives they want. You can only conserve energy so far.

DELEGATE: Well, I asked if this particular option causes any environmental problems. The ones in the Netherlands don't seem to.

COHEN: Well, for example, some people think the ones in the Netherlands look pretty. I'm not sure if those would be anything like the ones proposed to be built in the United States--probably like propeller-looking ones.

DELEGATE: There were some proposed for Vermont on a hillside which were opposed.

COHEN: They may in fact be on hills, and they'd be more conspicuous. You have to decide: do you want the energy or don't you like looking at that windmill? That's a fairly minor environmental impact it seems to me.

DELEGATE: The Environmental Director of Vermont said that he personally would never approve of putting any windmills on top of any mountains in Vermont for just that reason.

COHEN: That's his option, right? Somebody has to find some option that is satisfactory. We know these super-dams going back to hydropower are really a mixed blessing. There's a lot of resistance in putting in dams.

Now, I'll discuss renewable ocean energy and try to tell you what are the possibilities, and correct the misconception that tidal energy is ocean energy.

I've got a summary here of just what the possibilities of the ocean are. What is there? One of them is heat. Mentioned earlier, the ocean acts as a collector of solar energy. The surface gets warm and there's a lot of heat stored there over a tremendous expanse. In the tropical regions, the surface water gets to be 80 degrees Fahrenheit or higher. That's what I call molecular motion, otherwise known as thermal energy. These are various forms of kinetic energy. Then there are sources of kinetic energy that are more obvious. The water's moving. You can see that, and that's why I think partly the layman understands that. He doesn't see the molecular motion, but he sees the horizontal displacement otherwise known as currents or tides. These tend to generate electrical potential. There are also vertical motions in the water water, otherwise known as waves or swells, that are very obvious.

There's also something that's quite unobvious that could represent a significant source of energy, and that's salinity gradients that you have at the mouth of a river, for example. You've got fresh water mixing with salt water; and the difference in osmotic pressure between those two could, in principle, be harnessed because it represents potential energy that is being presently lost. There are also salinity gradients at sea that, in principle, could be tapped, but I'm not sure how likely that is.

So, there are at least five forms of renewable ocean energy, and then there's some rather subtle forms of energy in the ocean that ought to be listed for completeness. They include: using the ocean as a heat sink for power plants, which is increasingly being done. The ocean's power plants are migrating, just as people are, in search of a heat sink in their case and also in search of the people; they need to get rid of their rejected heat. They're rejecting heat to the ocean, which they find to be a convenient heat sink. The sink is a form of energy, if you want to look at it that way, because you need the heat sink to produce energy through a thermodynamic cycle. Also, the cold water which you find at depth, getting close to freezing the farther you go down, can be used as a source of coolness.

In other words, populations near the ocean can circulate that cold water and cool buildings. It's becoming more and more attractive. Another thing about the ocean is that it's a convenient source of feedstock hydrogen for the so-called hydrogen economy, and for the production of ammonia.

Any questions:

DELEGATE: You've left out the most important one: in the long run--the oceans as a source of deuterium.

COHEN: I haven't left it out. It comes in a later figure, but that fusion machine isn't operating, right? Wave energy--one person wanted to harness some of the wave energy by letting a float bob up and down; it pumps water and that water pumps uphill; then that will generate electricity, right? However, if you really look at these options on a world basis, and that was done by Isaacs & Seymour in an article from which I've copied figure 12 you look at all these sources in the ocean; the five that I've really emphasized here; and you see what the relative magnitudes of available energy might be if you have 33 million megawatts being produced. That's equivalent over a year to a total of one Q. So, if you take the worldwide energy in waves, and if you accept these numbers, you get 2.5 million megawatts worth of wave energy in the world. Tidal energy is about 2.7; ocean current energy is about 5 million megawatts; salinity gradients, counting the ones at sea, are about 1400, but the ones near the mouths of rivers are more like 3; and then the thermal resource in the ocean (the heat we're talking about) is 40,000 million megawatts.

DELEGATE: Is this if we harness every wave in the ocean?

COHEN: Something like that, yes. If you bring it close to home, I don't really know the answer for waves. Waves are a regional thing, and it has to be looked at more carefully. The wave energy is there, and it could be harnessed. It's a regional question. It's question that most the people who approach us on wave energy haven't worried about: what is the resource potential of the waves? For this country, we don't really know what the potential wave energy is, but we ought to look at that question before we start worrying about inventions to harness the waves. Professor Isaacs at the Scripps Institute of Oceanography has a wave machine that he can use to power an ocean buoy. That's another remote application where a wave energy device can be used if the wave energy there is adequate. He produces 5 kilowatts on an ocean buoy.

DELEGATE: I think one of the factors that will influence the exploitation of waves is the fact that when you remove the energy from the waves, the wave is no longer there to beat up ships and things; it's harmless. Therefore, it's an excellent breakwater.

COHEN: I'm not sure that's necessarily so, since breakwaters that are currently being used dissipate the energy; they don't convert it. I really think one ought to consider not just dissipating it, but harnessing it; and I wondered why they don't do that.

DELEGATE: Have you determined how much this would cut down the energy of a wave then?

COHEN: As you extract energy, it has to come from somewhere. Wave energy, by the way, is mainly wind energy. He's saying that as you extract more and more wave energy, the winds will feed more and more into the system. That's an odd way of collecting wind energy. They won't necessarily feed it in where you are extracting it; but this is a system where you actually can get ten times as much energy put in the system as you had there originally, if you start extracting some. Those questions need to be looked at hard, and none of these technologies will be implemented insofar as they have unfavorable impacts.

DELEGATE: What if we were to take the Panama Canal and put some turbine generators down there, and let the water run down different levels to the ocean. What impact would that have?

COHEN: I don't know if that would be a significant source of energy. If it's going to be looked at, it won't be by us. We're looking for significant ones. The tides do have a certain potential. We do know what that is for the U.S. and Canada. At the Bay of Fundy, you can get about 2000 megawatts out of that, which is not negligible. It is not a technological problem. The Carter Inlet, in Alaska is another place you can get some. Those things have been looked at for years. The technology really is available. Just a question of economics when that comes in. No problem of doing research and development on that one.

Now, ocean currents. A lot of people were excited, especially Floridians, about extracting energy from the Florida Current because they can see it rushing by. Obviously, there is some energy there. One estimate that I've heard, and it hasn't been refuted, is that there are about 25,000 megawatts. One is tempted to say that maybe this isn't correct, that probably no more than 10% of that can be extracted. So, you have about 2500 megawatts and on the average through the year, maybe 2000 megawatts could be obtained there, which is not to be sneezed at. However, we can't justify a research and development effort in that area with a total obtainable goal of 2000 megawatts. Our ocean program has yet to get into that, but I think a lot of the technology required will be in common with the thermal one, which I'll talk about in a minute.

Now, as far as the salinity gradients, I think there might be some considerable ecological considerations. Maybe the salinity differences could be tapped at the mouths of rivers by placing effectively a dam at the mouth of the river so that you divert fresh water in ways that you could, in principle, harness some energy there. I think the impact question and the resource question have to be looked at first in most of these areas before we branch out. Particularly, I'm concerned with the question of harnessing the salinity gradients and what the impact might be. One also needs to know what the resources are to begin with. Those two questions ought to be asked first.

Ocean thermal energy conversion was suggested 90 years ago by d'Arsonval, a French scientist. Maybe somebody had the idea earlier: why not extract heat from the oceans? There's a lot of it there. There's enough to run the whole world, in principle, if it can be harnessed in an economic, satisfactory way. That's still true. There's plenty of energy based on any contingent needs. The problem is it's low quality energy. It's there; the heat is there. The idea is simply to use the warm water at the surface of the ocean as a heat source, and the cold water at depth as heat sink, and run a heat engine between these two.

It's simply a question of pumping in the warm surface water and then exchanging heat with a working fluid like a refrigerant such as ammonia or propane. It's really a reserve refrigeration cycle. The warm water causes to evaporate a fluid like ammonia or propane, and that evaporating vapor then propels the turbine which generates electricity. The vapor is cooled in a condenser by the cold water that is brought up from depth. Then, that cool working secondary fluid is brought back again and recycled. It's a so-called closed cycle. Very simple. No fuel is required, just heat exchangers, a turbine and a few pumps. (See Figure 13) The only problem: what will that cost: We know we can do it technically. In fact, it was done by Georges Claude, another Frenchman, in 1929. He produced 22 kilowatts of power for a few weeks until his cold water pipe snapped. It can be done, and the only problem is--and we've seen this as another big potential pay-off--there are some risks and questions on the economic, technological, and political feasibility of what a plant like that might be like.

One of our U.S. pioneers in this field who's been talking about the possibility for ten years, J. Hilbert Anderson, has developed many versions of plants of this type. One such plant would be three hundred meters across and produce 100 megawatts (Figure 14). We don't really know the optimum size for the plant, but plants as large as four hundred megawatts or so may be feasible.

The question of impact comes along: what is the effect of circulating all this water: what is that going to do? Everything you do in energy has a thermal consequence, and there are other consequences involved with circulating a lot of water because the efficiency of this process is quite low. As I said, it's a low quality heat. The theoretical efficiency is no more than 6 or 7%; we might get a net efficiency of a half or third of that.

What are the products we can produce out at sea? The ocean is an interesting place, but it's also somewhat remote. Let's just summarize what can be done out at sea besides what I've mentioned already.

There is a lot of real estate out there. You can collect solar radiation; we talked about the technological ways. You can also collect wind energy at sea. You can do mariculture at sea. You can also harness the geothermal that lies under the ocean. What are the products, and what are you going to do with them?

Floating mariculture facilities are being suggested to grow kelp. There'll be kelp farms. There is an experiment going on right now of this sort where you grow kelp out at sea. It would be viewed as an energy crop. Mariculture could work very well, by the way, with the ocean thermal one where we bring up the cold water, and along with it a lot of nutrients that can be used as fertilizer for the mariculture operation, and too, shellfish or various kings of fish and/or crops that will produce proteins and fuels. The whole question is the cost and feasibility of doing that. In fact, the Humboldt Current does it naturally off Peru. We've been talking about producing artificial fertilizer to fertilize crops at sea, and those crops can then be upgraded to fish.

This is a summary, then, of some of the products you can get at sea, and you have got to do something with the energy. You get electricity in the first instance, mechanical energy in flywheels if you want to: and chemical energy such as hydrogen. Also, you can take mitrogen from the air and hydrogen from the water and make an energy intensive product like ammonia which is currently in short supply. It can be used either as fuel or fertilizer. You can effectively ship a lot of fuel back home right there and then, because you don't need to produce the ammonia back home anymore. You "virtually" ship the fuel back home, ship the ammonia where you want. Methanol is another attractive product. There can be an energy umbilical, if you're close enough to shore to get the energy back to the beach. You can use an energy umbilical comprised of an electric cable if you're close enough, and also compressed air can be shipped ashore. You can store and ship energy in the form of heat also.

Some of the by-products that can be produced are the mineral nutrients, i.e., fertilizers, that are brought up from the depths. One can extract minerals at sea, from the sea. One can produce fresh water, of course, in many of these processes. Offshore nuclear plants can do all these things too. One could produce hydrogen (I think hydrogen is overemphasized, but I've referred to it just to be complete) and then, one can extract deuterium and maybe lithium. I'm not sure how economical lithium is, and I'm not sure what it costs, energy-wise, to extract deuterium.

Just a few words on geothermal energy. This is a very controversial subject as far as its resource potential. Just how much energy is there? Clearly, it could be a significant source, and now there's a lot more emphasis being put on this.

Just to give you some numbers again, the NSF had about three million dollars for geothermal last fiscal year. This year we're down for 23 million. They're making a dramatic increase in this area and the other two agencies I mentioned, the AEC and the Department of the Interior, will get a comparable amount between them. Happily, I think we are looking at this alternative more vigorously. In some sense geothermal is not necessarily renewable. You might have to let it set around for a few hundred years and recharge after you had extracted what you had in a given well. I don't quite know the story on that, but in a sense it's renewable. You can get this now from various sources. These geysers shooting up steam are an obvious sort of formation that one can tap, and you can use ones that are not so visible.

In California, they've got a formation known as the Geysers that gets 490 megawatts out of it. (See Figure 15) That's steam, and there is also brine, hot water which is very saline, that can be used. Also, there is the possibility of extracting heat from dry rock. You have to go down further, but there's a lot of hot, dry rock down there. You could go down four kilometers or so with some working fluid and get that warmed up and run it through a power cycle. A geothermal steam turbine is being used at the Geysers by Pacific Gas and Electric Company in California. Again, this is a regional application. We don't really know too much about where this resource might be, but it tends to be West of the Mississippi.

A lot more work needs to be done on exploration techniques and much of this is being funded. Some of the controversy over the use of geothermal is raging and continues to rage, but nobody knows the answer really. Some of the forecasts are rosy, and a lot of them depend on how well we implement the technology required to achieve goals like these. There's a whole range of opinion, but nobody, questions that there's a significant amount of geothermal energy. Happily, geothermal hasn't been developed until now, hence we will probably handle its environmental impact more satisfactorily than we would have earlier.

There's only about 1000 megawatts of geothermal energy around the world, in fact. Some of these plants look and sound a mess. That's also a problem. There are environmental impacts on land, water and air. There are potentially significant impacts that one has to be concerned with. (See Figure 16) One has to give a lot of attention to these potential impacts. I think now we're more likely to do that than we would have been ten or twenty years ago.

One feature of geothermal that tends to detract from it is the fact that it isn't necessary to locate it where the people are located. However, when it is located one could build a new town there rather than bringing the energy where the people are, as we typically do. As we over-extend our urban systems by moving energy where the people are, why not set up new towns where there is geothermal potential? Typically, locations for towns were decided upon by other resource considerations, such as water and transportation. All we have to do is locate a geothermal potential and then look for the water and transportation.

To summarize after all this hodge podge of material. It isn't true that a-l these nice sounding energy sources that we talked about don't have an impact. They do. One of our problems, I think, is that we're a little short-sighted. We've got a fad now, and it's known as energy. This meeting is a manifestation of the fad. We're talking in the currency of energy now, when that in fact, is only one resource. The problem is really a resource problem, and energy is just one of the resources. A lot of our societal problems are not resource problems, but a lot of them are. Energy is just part of the picture on the resource question. What we really ought to be talking about is optimization of our use of resources.

Among these resources are land, water and air. When you take the energy out of the land, water, or air or whenever you do something involving energy, these are intensively wound up in it. These are what we're calling environmental impacts. Let's just say that our real problem is to optimize our use of resources: energy, land, water, and air. There was a fifth resource, but at least we ought to consider those four. I'll think of it later. Question?

DELEGATE: How about minerals?

COHEN: I think you're right. Actually, there is a problem, and society is also hoodwinked on this problem. Of course, nobody here is. That is, we think that because of technological fixes, we can violate certain laws like conservation of matter or conservation of energy. Somehow society thinks that we can magically solve everything technologically, but there is a limit to the amount of energy. There is a limit to all these resources along with the energy. Each interacts with the others. Materials; that ought to be number five. Maybe I'm thinking of a sixth one too, but we've got to optimize the use of resources. That's really what these environmental impact questions come to. You want the energy, and yet you want to use it in a satisfactory way.

These problems really ought to be regarded inaa dimensional way, whatever that is, five or six. We're really trying to optimize the mix. It isn't energy alone that we ought to be focusing on, but resources. I think we're going to have a crunch on food resources, and on water resources, along with the energy resource. What we ought to be talking about is resources, of which energy is only one aspect, but it's a fairly fundamental one. The tendency is to interact in such a way that you really have to have a lot of energy and use it wisely.

In closing, one final point about the solar option and all these options we talked about. Just as man does not live by bread alone, I think it isn't just a question of economics that ought to come into this equation. It shouldn't simply be the relative cost of these energy options that enters the equation. Basically, I guess some of you probably understand that the costs do not include externalities. These are external diseconomies according to the economists. The prices we talked about here are simplifications. Price alone isn't all that matters. From one standpoint, the environmental desirability, which tends to be relatively in favor of solar options, isn't cranked in. We don't get credit for that in pure cost determination. It has some value, but it isn't internalized so we're not getting credit for that. In many cases it shouldn't be thought of merely in terms of economy, and yet we don't bring that into the picture typically. So, one has to think a little bit more profoundly about that one.

The other feature that I think should commend itself to many of you here who are ecology-minded or biologically-minded is that in going to more diversified systems of bringing in these alternatives to an optimum amount, you have an analogy to an eco-system. You've added diversity. You've added a certain stability into the system. The worst example of this lack of diversity is the transportation situation in this country. We have removed the diversity and when something adverse happens, we really suffer. If something adverse happens involving the motor car, such as the absence of gasoline it really paralyzes society. I think we are too hooked on the motor car, and we haven't introduced a diversity in that technology--transportation technology.

We're beginning to make moves in that direction; but in energy technology, many of these solar energy options are, in fact, concentrated sources of power just as we have now, and just in electrical plants. When you're relying on concentrated sources of power, that's dangerous, as we've seen from blackouts and brownouts. What we add to the system in going to these diversified options is not internalized, but it's a very valuable thing, and it ought to be internalized. That is, it makes the system more stable; it makes the distribution of energy in heating and cooling a building more stable, as an example. You aren't at the end of any pipeline; you aren't at the end of anybody's electricity line. You've got your own source right there.

The more one reflects about that, the more I think it comes home that a lot of these factors don't reflect themselves in the economics, but we really ought to be looking hard at all of these alternatives and technologies. I think I've only talked about part of them. There are a lot of technologies that need more and more emphasis. It's just unfortunate that we haven't done it sooner. We'd have a lot more options today, and the society would be much more stable because of that.

I'll conclude by anseering a question you didn't ask. Which is: the impact of most alternative energy technologies, including coal gasification, will not begin to be manifested until the mid '80's. That goes for the breeder and most solar options. About all we can do until the mid '80's is conserve energy to really have an effect. The new energy options won't really become available until the mid '80's. It's anybody's guess how soon and how fully we implement any of these things. I personally don't like to forecast the future. We've got enough problems trying to prepare for it. I think it depends on how well we implement these technological studies and ocean-thermal. We hope to have what we call a proof-of-concept experiment by 1980 or so, to produce 10 or 25 megawatts of power out at sea. By the mid '80's we think we might have demonstration plants, maybe 1000 megawatts worth altogether. We really think we can take off at that point and produce a significant amount of power that you people would all live to see. Certainly by the end of the century, we would have lots of ocean thermal energy capability, assuming success. It's dangerous to predict, largely because we don't know how it will go...

Figure 1

Comparison of Estimated Energy Content in World's Economically Recoverable (Based on Current Market Prices) Fuel Deposits

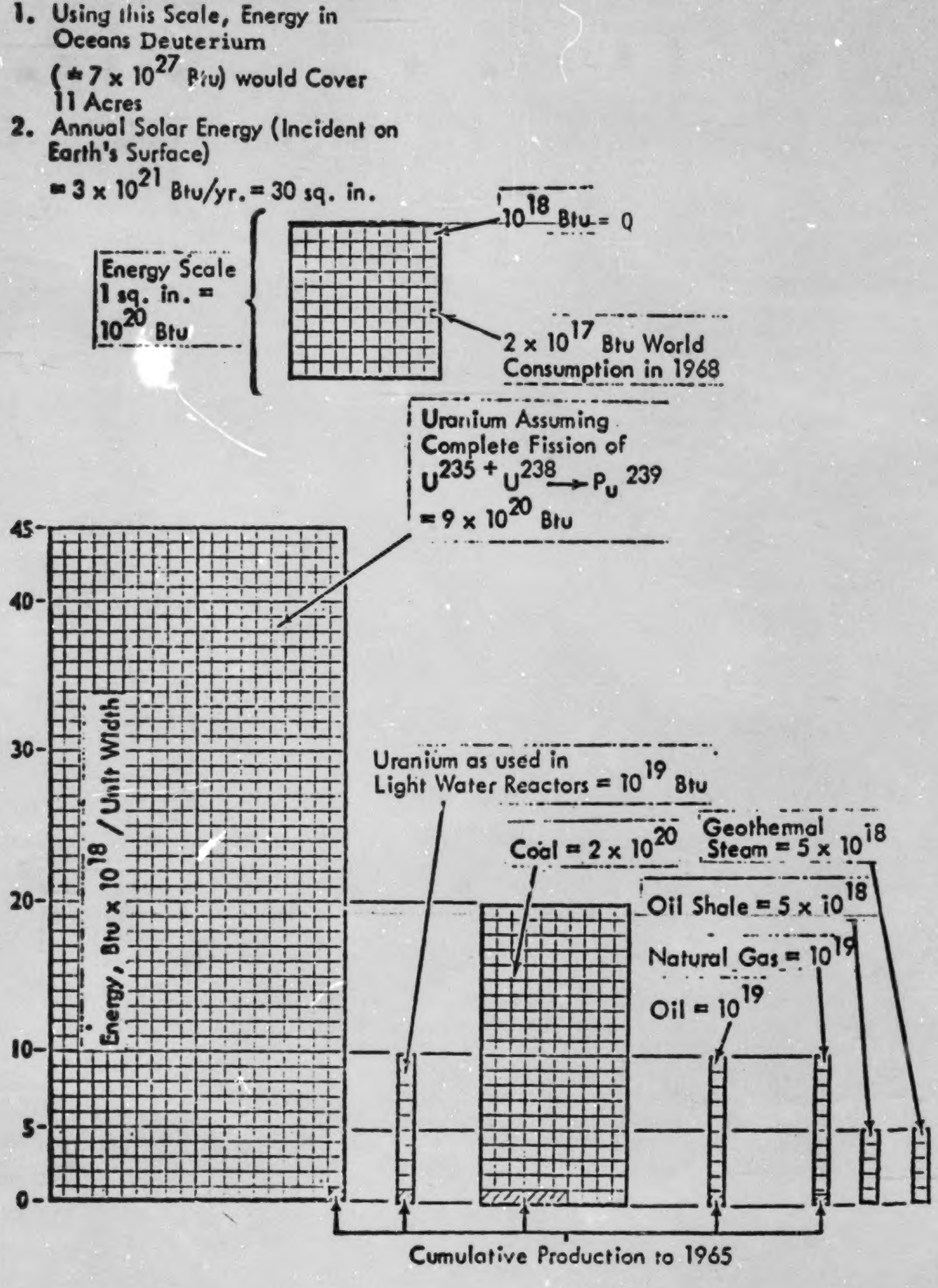


FIGURE 2

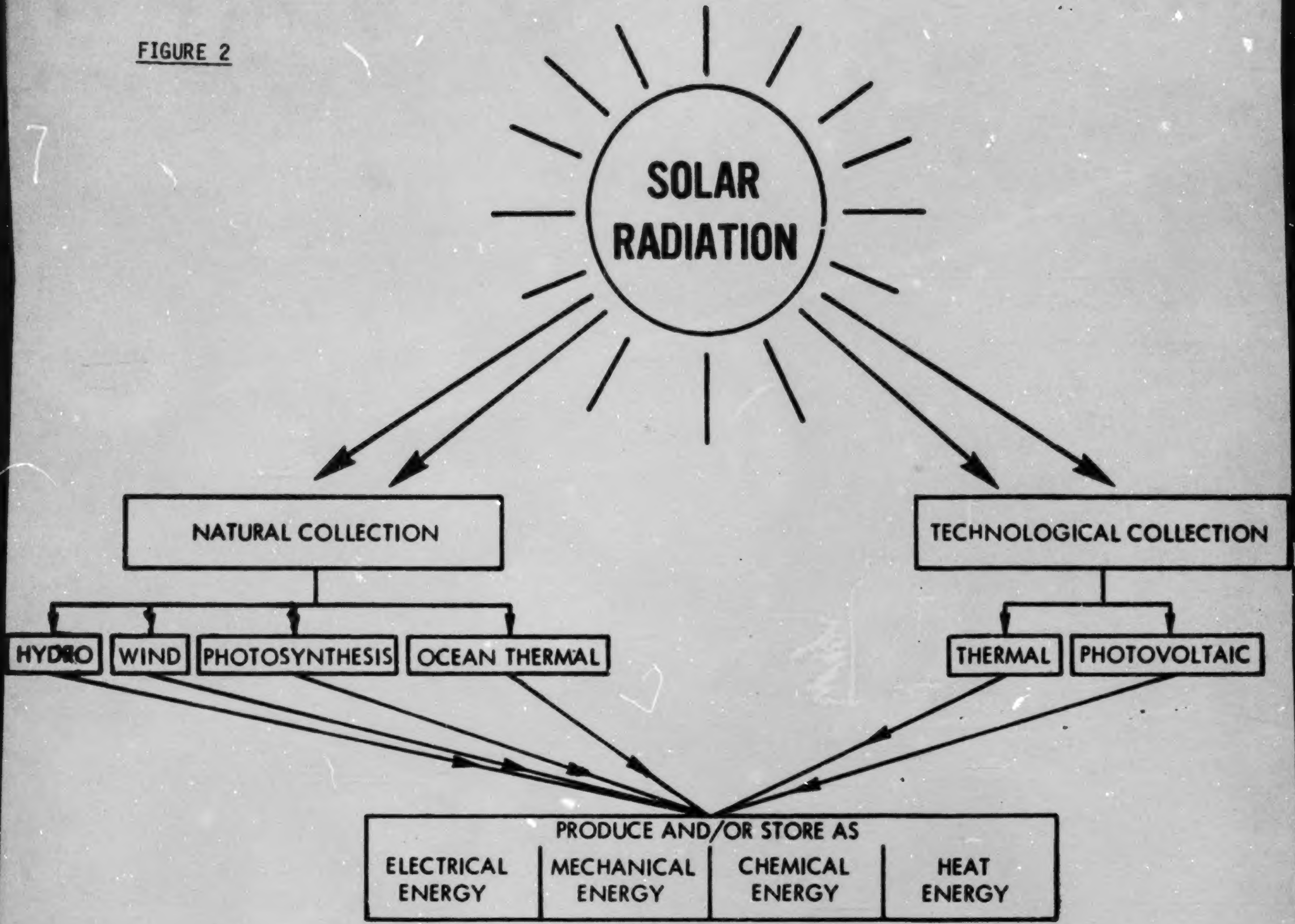

SOLAR RADIATION
NATURAL COLLECTION
TECHNOLOGICAL COLLECTION
HYDRO
WIND
PHOTOSYNTHESIS
OCEAN THERMAL
THERMAL
PHOTOVOLTAIC
PRODUCE AND/OR STORE AS
ELECTRICAL ENERGY
MECHANICAL ENERGY
CHEMICAL ENERGY
HEAT ENERGY

FIGURE 3

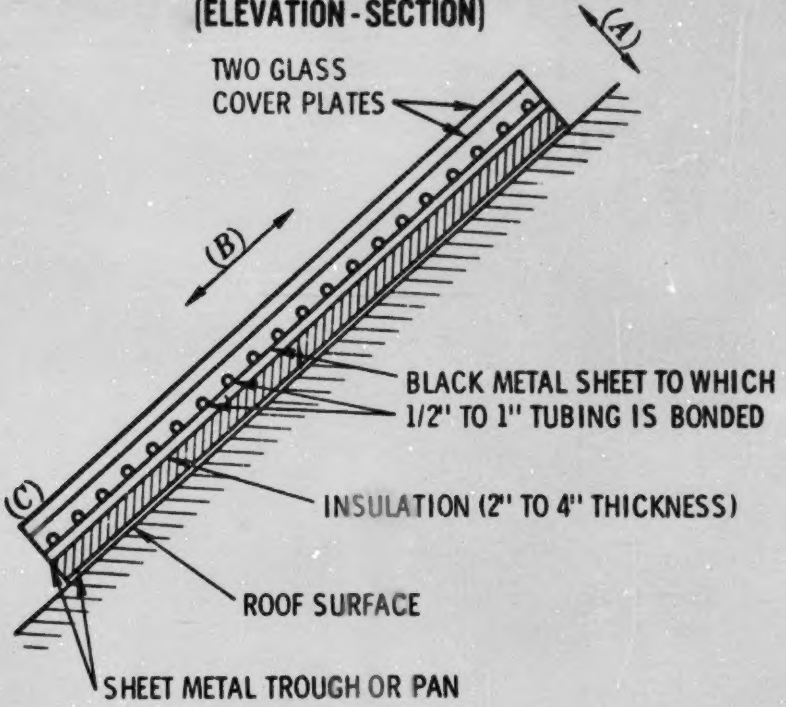
NSF/RANN SOLAR ENERGY BUDGET

(IN THOUSANDS OF DOLLARS)

	FY 1971	1972	1973	1974 (EST.)	1975 EST.
HEATING AND COOLING FOR BUILDINGS	$ 540	100	400	5,900	17,000
SOLAR THERMAL TO ELECTRICAL	60	550	1,430	2,200	10,000
PHOTOVOLTAICS		330	790	2,400	8,000
BIOCONVERSION TO FUELS	600	350	650	1,000	5,000
WIND ENERGY CONVERSION			200	1,000	7,000
OCEAN THERMAL ENERGY CONVERSION		140	230	700	3,000
$\sum$ =	$ 1,200	1,600	3,960	13,200	50,000

FIGURE 4

SOLAR COLLECTOR FOR RESIDENTIAL HEATING AND COOLING
DIAGRAMATIC SKETCH OF ONE ALTERNATIVE
(ELEVATION-SECTION)

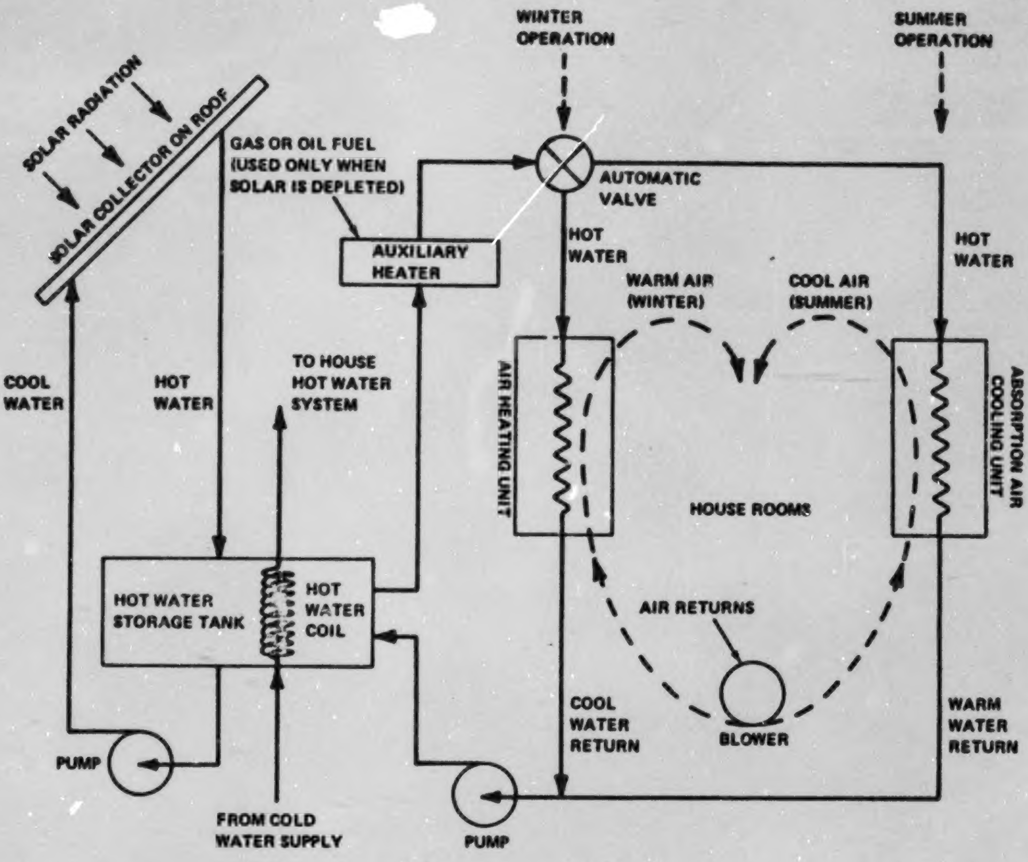


(A)
TWO GLASS COVER PLATES
(B)
BLACK METAL SHEET TO WHICH 1/2" TO 1" TUBING IS BONDED
(C)
INSULATION (2" TO 4" THICKNESS)
ROOF SURFACE
SHEET METAL TROUGH OR PAN

NOTES: ENDS OF TUBES MANIFOLDED TOGETHER
ONE TO THREE GLASS COVERS DEPENDING
ON CONDITIONS

DIMENSIONS: THICKNESS (A DIRECTION) 3 INCHES TO 6 INCHES
LENGTH (B DIRECTION) 4 FEET TO 20 FEET
WIDTH (C DIRECTION) 10 FEET TO 50 FEET
SLOPE DEPENDENT ON LOCATION AND ON
WINTER-SUMMER LOAD COMPARISON

FIGURE 5


WINTER OPERATION
SUMMER OPERATION
SOLAR RADIATION
SOLAR COLLECTOR ON ROOF
GAS OR OIL FUEL (USED ONLY WHEN SOLAR IS DEPLETED)
AUTOMATIC VALVE
AUXILIARY HEATER
HOT WATER
HOT WATER
WARM AIR (WINTER)
COOL AIR (SUMMER)
TO HOUSE HOT WATER SYSTEM
COOL WATER
HOT WATER
AIR HEATING UNIT
ABSORPTION AIR COOLING UNIT
HOUSE ROOMS
HOT WATER STORAGE TANK
HOT WATER COIL
AIR RETURNS
COOL WATER RETURN
BLOWER
WARM WATER RETURN
PUMP
FROM COLD WATER SUPPLY
PUMP

RESIDENTIAL HEATING AND COOLING WITH SOLAR ENERGY: SCHEMATIC DIAGRAM OF ONE ALTERNATIVE

FIGURE 6

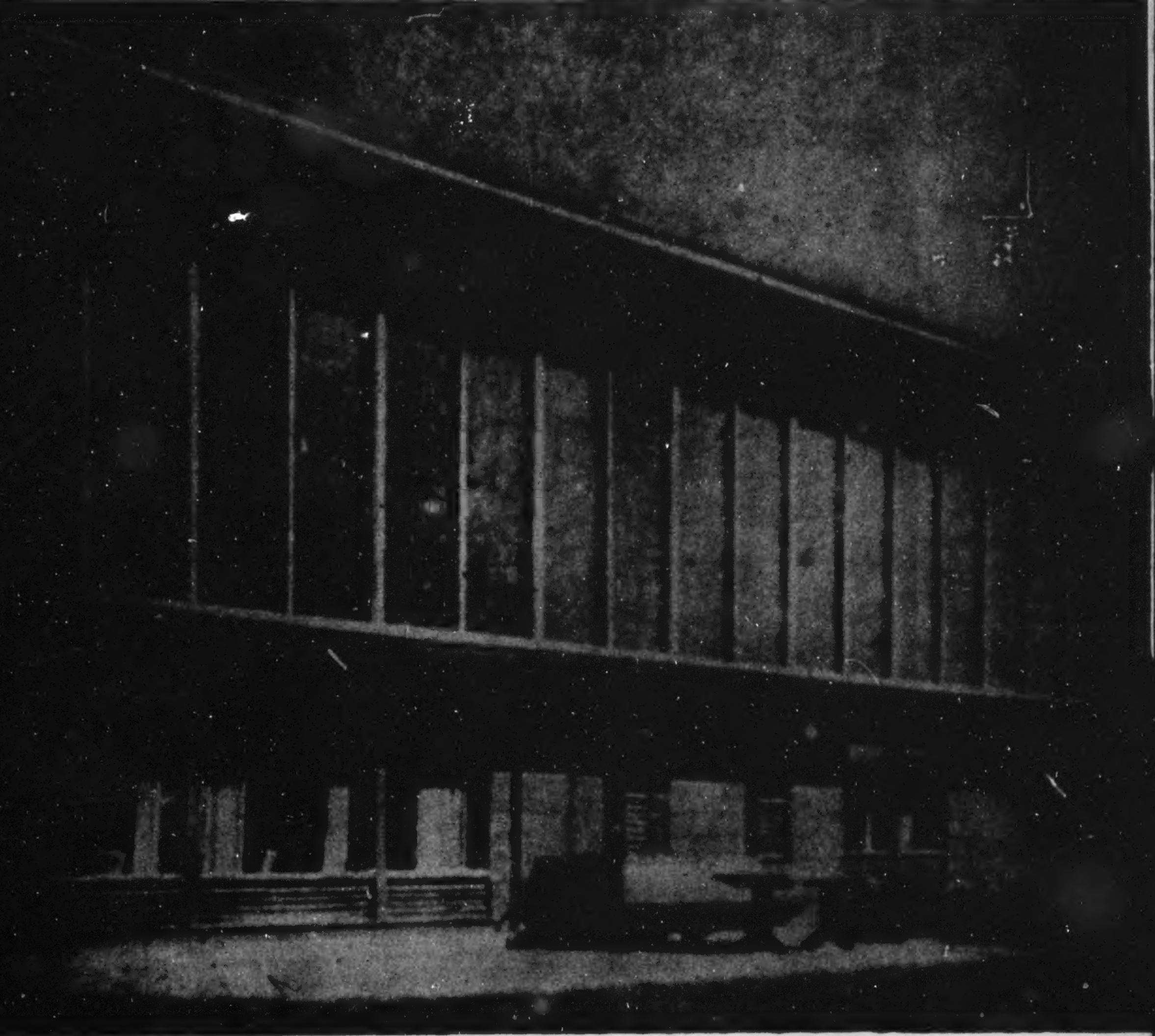
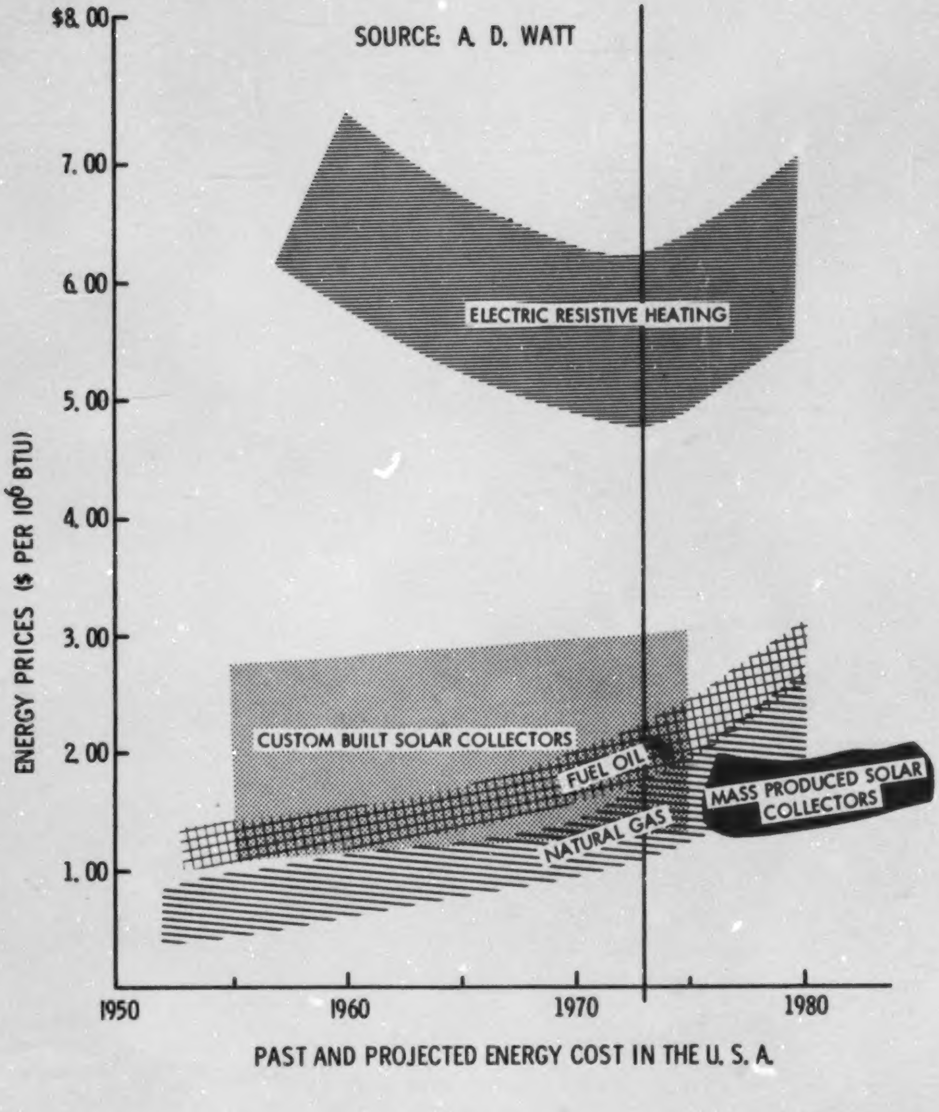


FIGURE 7



PAST AND PROJECTED ENERGY COST IN THE U. S. A.

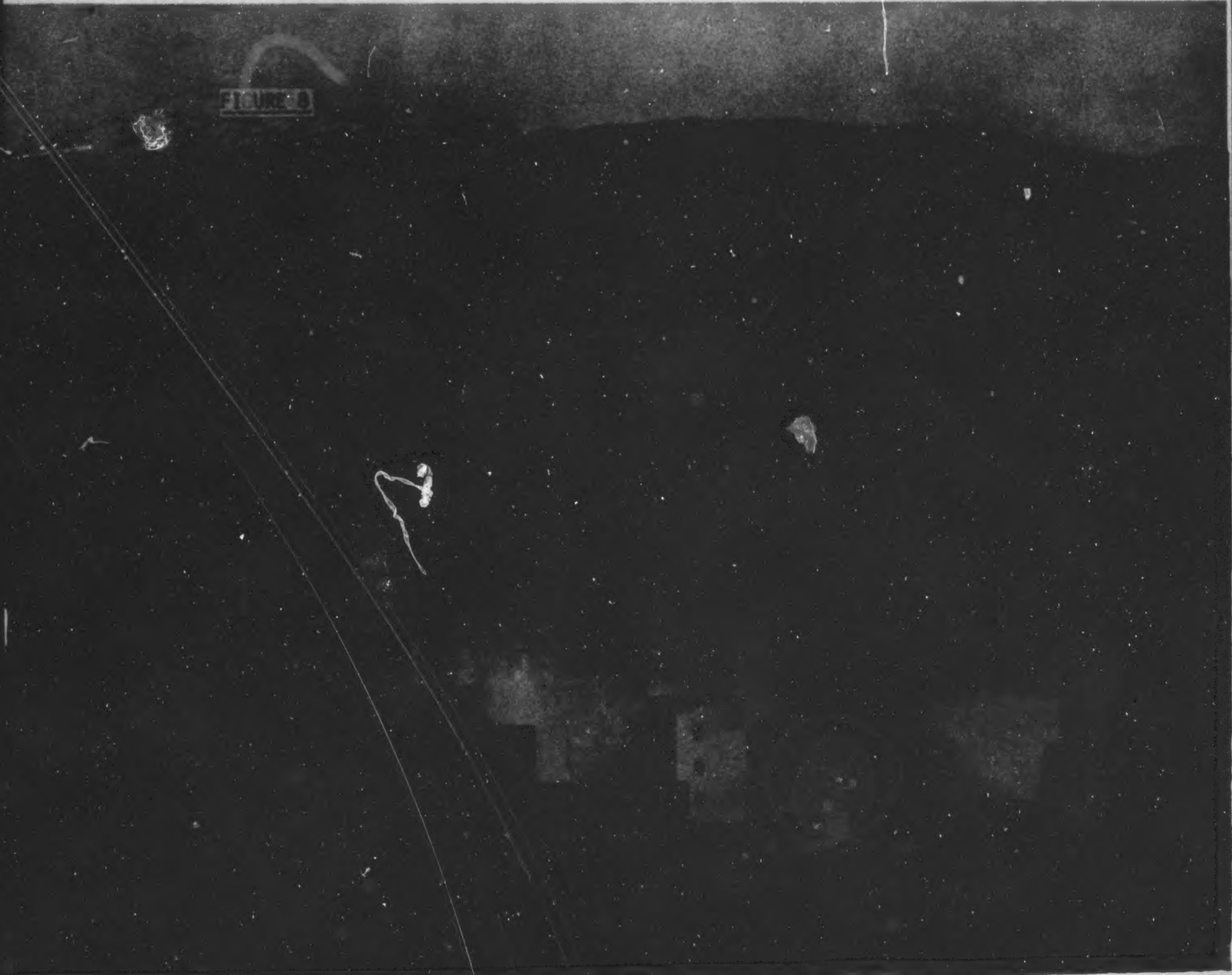


FIGURE 8

FIGURE 9

PRODUCTION OF FUELS FROM SOLAR ENERGY

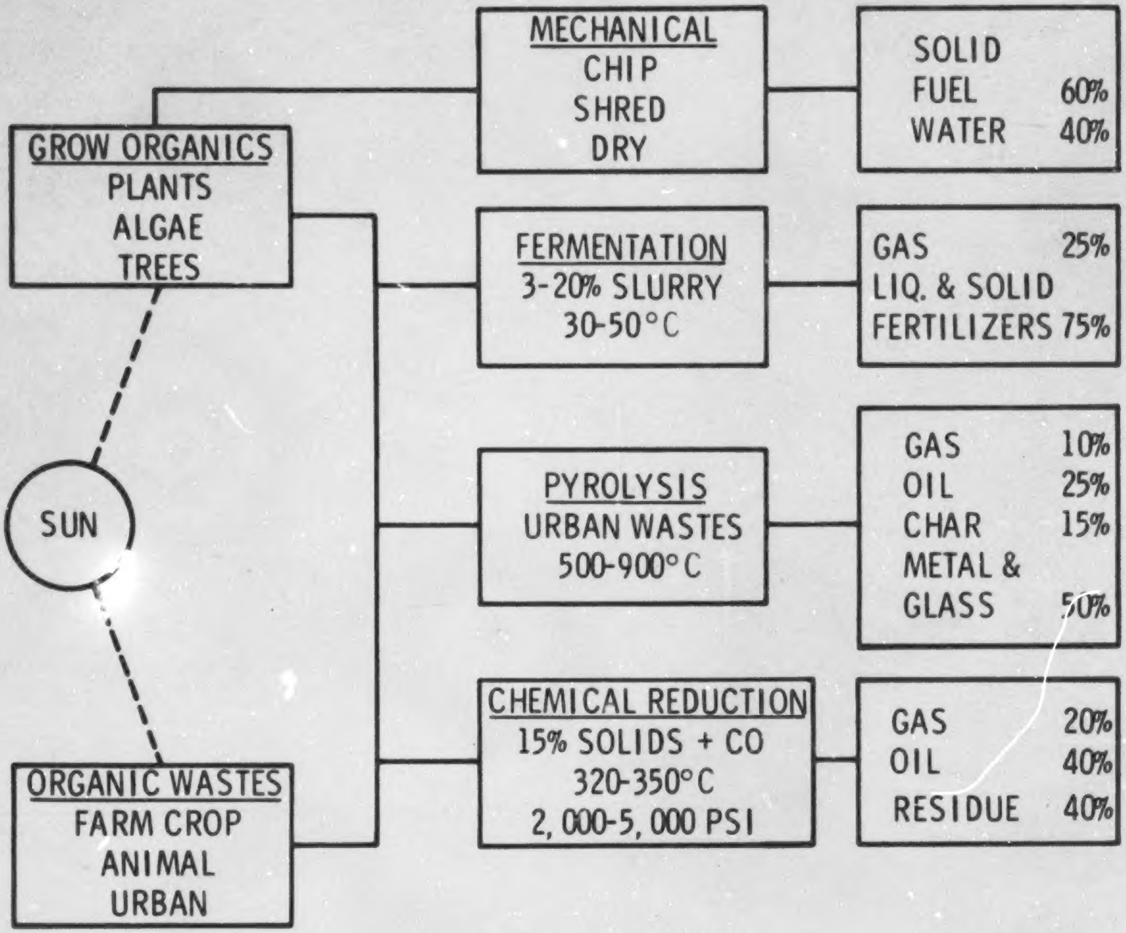

GROW ORGANICS
PLANTS
ALGAE
TREES
SUN
ORGANIC WASTES
FARM CROP
ANIMAL
URBAN
MECHANICAL
CHIP
SHRED
DRY
SOLID
FUEL 60%
WATER 40%
FERMENTATION
3-20% SLURRY
30-50°C
GAS 25%
LIQ. & SOLID
FERTILIZERS 75%
PYROLYSIS
URBAN WASTES
500-900°C
GAS 10%
OIL 25%
CHAR 15%
METAL &
GLASS 50%
CHEMICAL REDUCTION
15% SOLIDS + CO
320-350°C
2,000-5,000 PSI
GAS 20%
OIL 40%
RESIDUE 40%

FIGURE 10

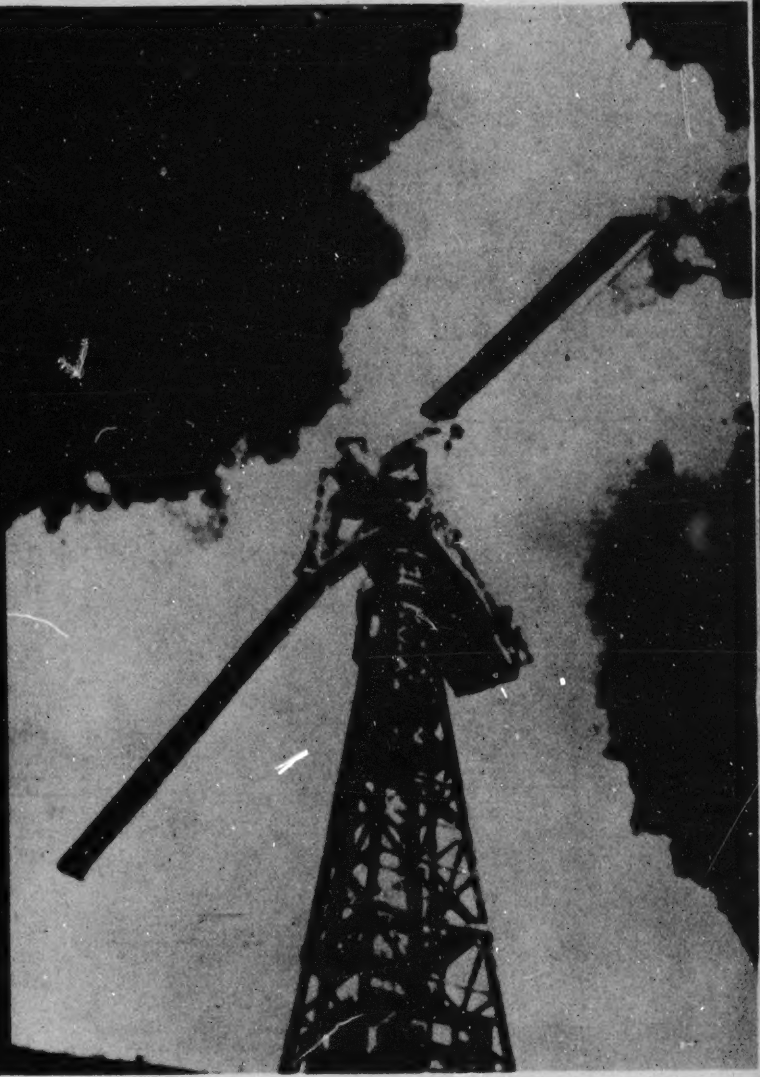


FIGURE 1: LINE WITH EXISTING DESIGN

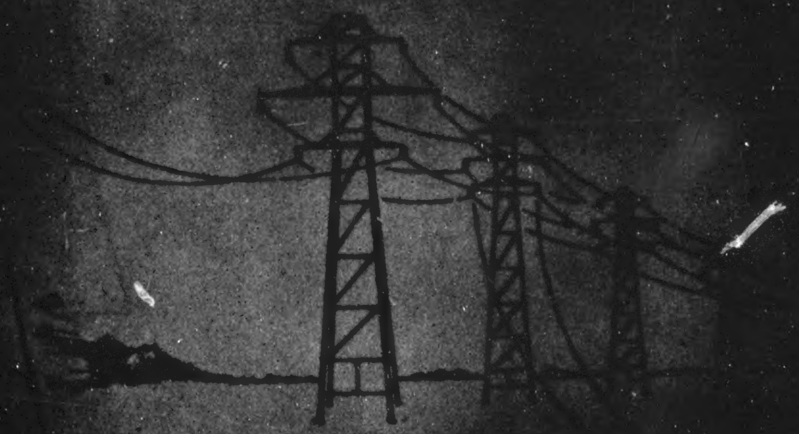


FIGURE 12

ESTIMATES OF POWER DISSIPATION RATES IN THE OCEANS

JOHN D. ISAACS AND RICHARD J. SEYMOUR

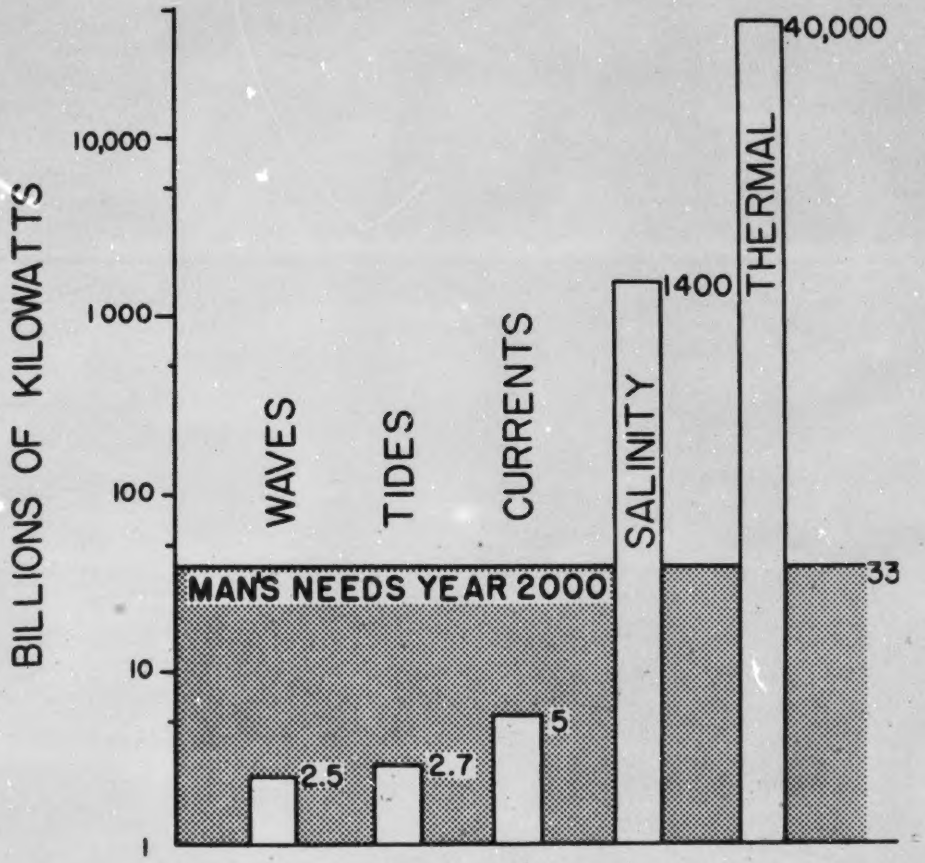


FIGURE 13

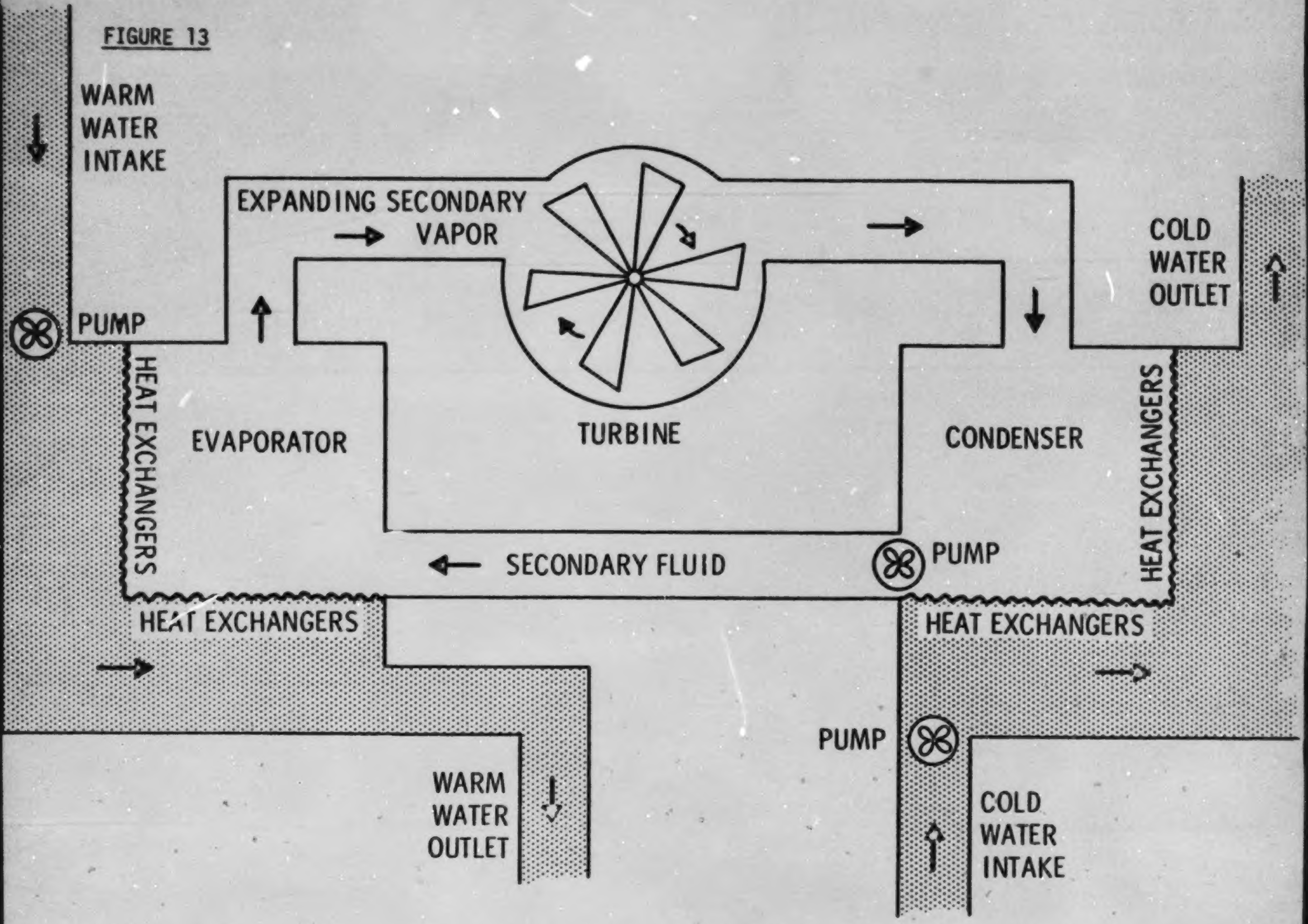

WARM WATER INTAKE
PUMP
EXPANDING SECONDARY VAPOR
TURBINE
COLD WATER OUTLET
HEAT EXCHANGERS
EVAPORATOR
CONDENSER
HEAT EXCHANGERS
SECONDARY FLUID
PUMP
HEAT EXCHANGERS
HEAT EXCHANGERS
PUMP
WARM WATER OUTLET
COLD WATER INTAKE

FIGURE 14

C CONDENSER
D PUMP HOT WATER (4)
E OUTFALL WARM WATER (4)
F INTAKE COLD WATER
G OUTFALL COLD WATER
H TURBINES
I PUMP COLD WATER
I
F

FIGURE 15

FORECASTS OF POTENTIAL ELECTRIC-POWER CAPACITY FROM GEOTHERMAL ENERGY RESOURCES

SOURCE	POTENTIAL CAPACITY (MW)	CONDITIONS
REX AND HOWELL (1973)	400,000	IN U.S. BY ~1990 WITH A PROJECTED LIFE OF 100 YEARS
HICKEL (1972)	132,000	IN U.S. BY 1985 WITH SUFFICIENT RESEARCH AND DEVELOPMENT
WHITE (1973)	30,000	WORLD-WIDE MAXIMUM AT PRESENT PRICES AND TECHNOLOGY
NATIONAL PETROLEUM COUNCIL (1972)	3,500 TO 19,000	IN U.S. BY 1985 UNDER FOUR SETS OF ASSUMPTIONS
CALIF. DIV. OF OIL & GAS 1972 (IN S.R.I., 1973)	7,500	IN CALIFORNIA BY 2000
S.R.I. (1973)	1,800	IN CALIFORNIA BY 1985
	4,400	IN CALIFORNIA BY 2000

FIGURE 16

ENVIRONMENTAL IMPACTS OF GEOTHERMAL POWER PRODUCTION

LAND

Land Utilization
~2 km^2/100 Mw

Drilling Operations
~20 Wells/km^2

Power Plant Construction
1 plant/100 Mw

Steam Gathering Lines
~0.2 km/100 Mw

Condensate Reinjection
Lines and Pumps

Potential for
Land Subsidence
Seismic Activity

WATER

Disposal of
Drilling Fluids

Need for Supplementary
Cooling Water

Build-up of
Salt Concentrations

Disposal of
Condensor Cooling Water
Steam Condensate
~3.5 Mgpd/100 Mw

Potential Mineral and
Thermal Pollution of
Fresh Surface Waters

AIR

Release of Steam
and Other Gases
during Drilling
and Testing

Noise Pollution

Release of H_2S and
Other Non-condensable
Gases

Potential Changes in
Micrometeorology

FUEL CELLS
NEW OPTIONS FOR ELECTRIC GENERATION

James D. Brown, Assistant Manager, Fuel Cell Marketing
Power Utility
Division of United Aircraft Corporation

INTRODUCTION

The fuel cell converts chemical energy directly into electricity by an electrochemical process. Fuel cell powerplants are quiet, clean and efficient throughout a large range of power levels and at part power. They offer new options to complement existing electric generation systems that will conserve fuel, reduce the cost of electricity, and protect the environment.

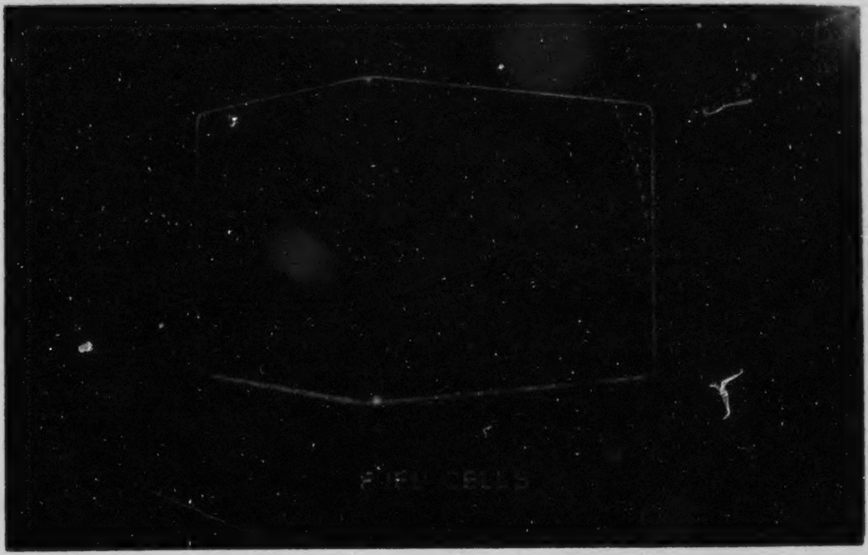
The fuel cell is described briefly and its characteristics, potential applications and benefits presented herein.

Shown here is the scope of fuel cell activity at Power Utility Division during the past 15 years. While our hydrogen-oxygen fuel cell activity continues beyond Apollo to the NASA Space Shuttle, Navy underwater applications, and high performance Air Force research, our principal thrust is now devoted to bringing hydrocarbon-air fuel cells into commercial electric generation service by the end of this decade. This will provide new and desirable options for electric generation.

SCOPE OF FIFTEEN YEARS EXPERIENCE

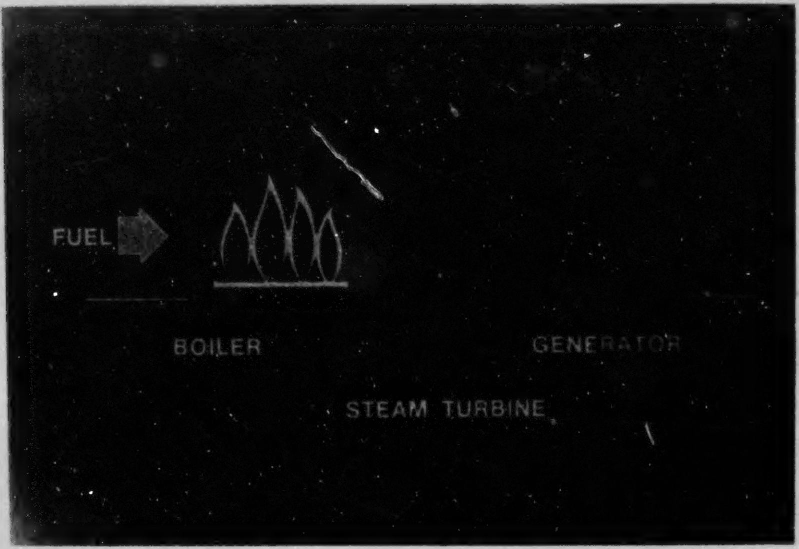
- **ACTIVITY**
  - SPACE POWER–USAF, NASA
  - UNDERWATER POWER– NAVY, COMMERCIAL
  - MILITARY GROUND POWER–ARMY, USAF
  - COMMERCIAL GROUND POWER– GAS UTILITIES, ELECTRIC UTILITIES, AND NON-UTILITY COMMERCIAL PROGRAMS
- **INVESTMENT**
  - OVER $250 MILLION BY GOVERNMENT, UTILITIES, AND P&WA FOR R&D AND PRODUCTION
- **RESOURCES**
  - 900 PEOPLE
  - 200,000 FT^2 FACILITY

The secret of the fuel cell powerplant lies in its stack of fuel cells which convert fuel energy directly into electricity.

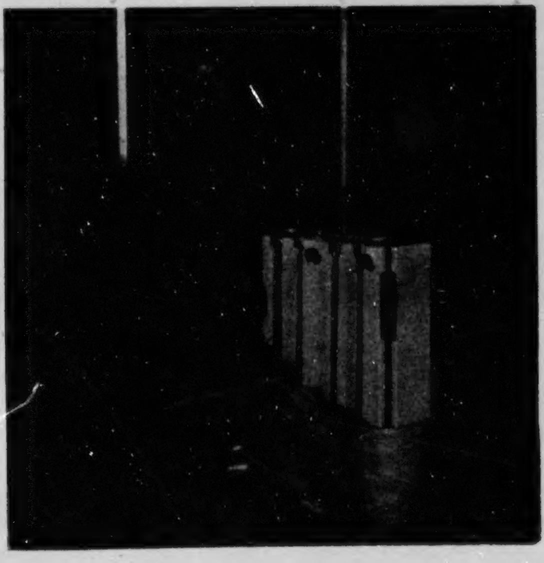


Other components of the fuel cell powerplant condition the fuel supplied to the fuel cells, and convert the direct current they generate into conventional high quality alternating current.

Unlike conventional power generating systems which burn fuel to turn heavy generating machinery . . . .


FUEL
BOILER
GENERATOR
STEAM TURBINE

fuel cells work electrochemically, without combustion or rotating conversion machinery, making a fuel cell powerplant extremely quiet.

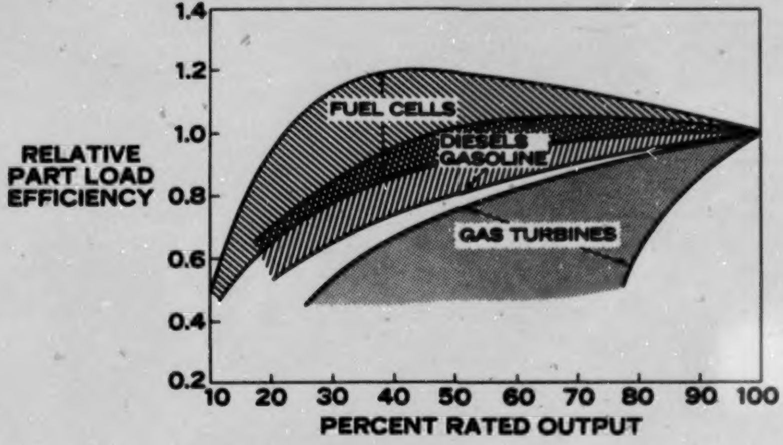


Fuel cells are the most efficient systems yet devised for generating electric power.

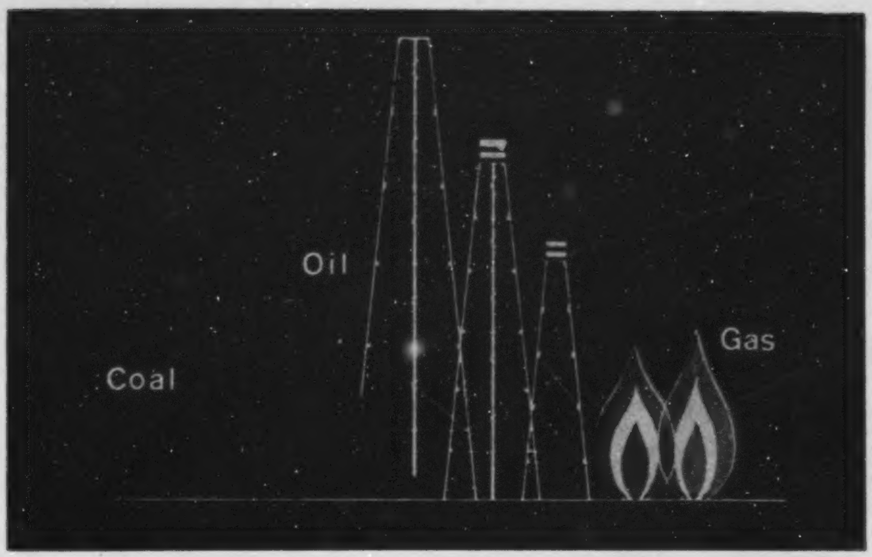
EFFICIENCY

And their efficiency at partial load is unsurpassed. This is important because powerplants are frequently operated at part load to match the demand.

OFF-DESIGN PERFORMANCE FOR TYPICAL ENERGY CONVERSION SYSTEMS



This high efficiency conserves our vital fuel resources . . . .


Oil
Coal
Gas

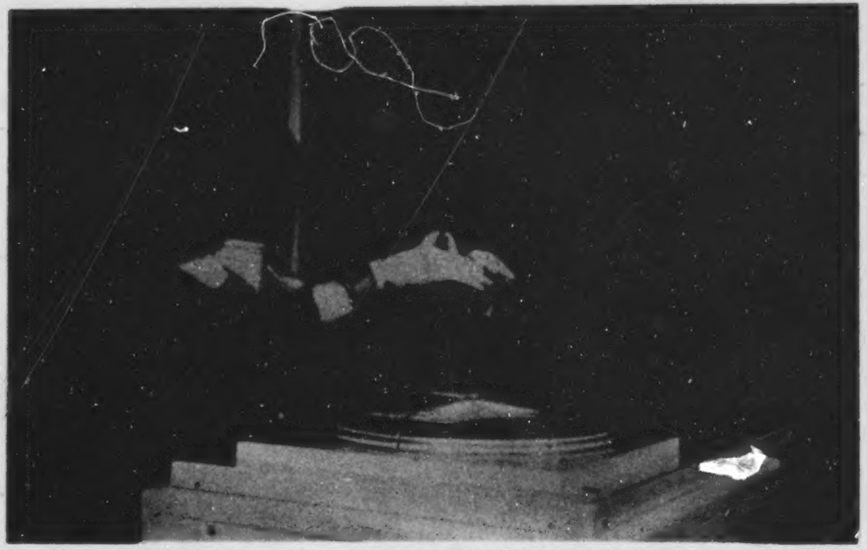
and can result in fuel savings of more than 25 percent.

ERAL RESERVE NOTE
TED STATES OF AMERICA
A 008
1
ONE DOLLAR
1

Fuel cells virtually eliminate air pollution. They produce less than one percent of the pollutants emitted by conventional generating systems using coal or oil.

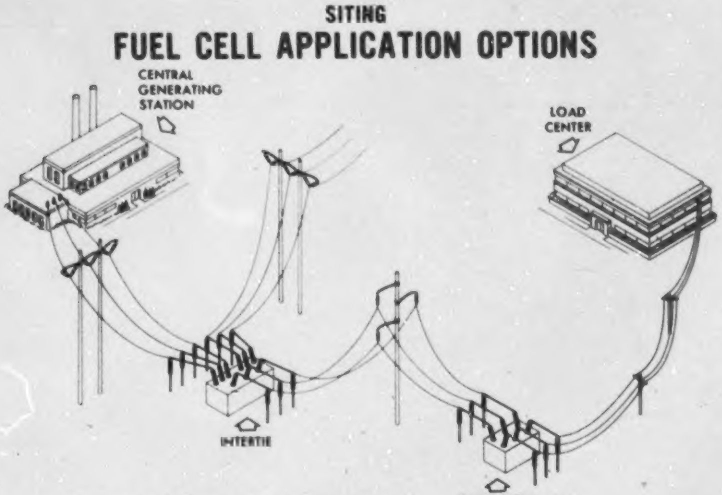
AIR POLLUTION

In fact, they are so clean they pass the white glove test. They are also air cooled, thus eliminating the need for cooling water.



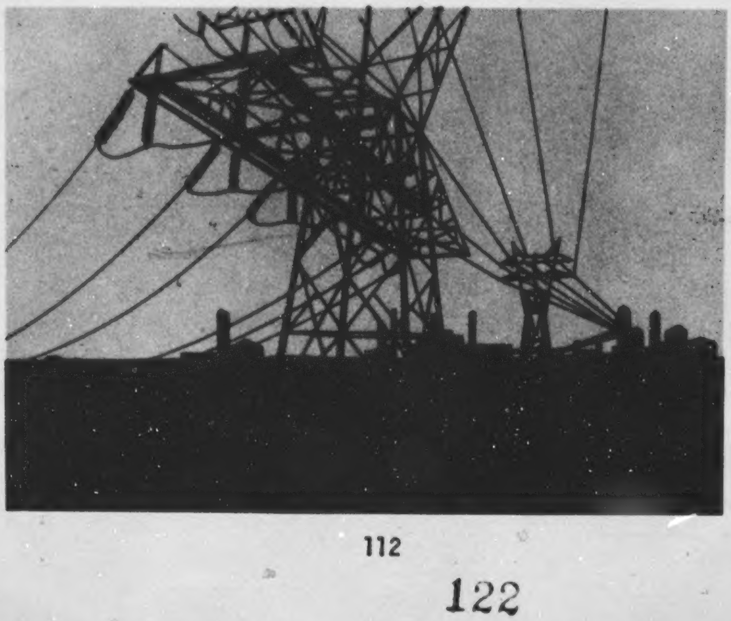
Where might they be used?

Because fuel cells are clean and quiet, are efficient regardless of generating size, don't need cooling water and are modular, they can be placed at many locations unavailable to conventional generating equipment. Shown here is a conventional electric system – the generating station, high voltage transmission intertie, a substation which reduces transmission voltage to distribution levels and the load center where the electricity is used. In the conventional system electricity is made only in the central generating station. Because the fuel cell is a "good neighbor" it can be located at any of these sites. Location at a substation . . . .



- FUEL CELLS CAN BE LOCATED AT OPTIMUM SITES IN THE UTILITY SYSTEM

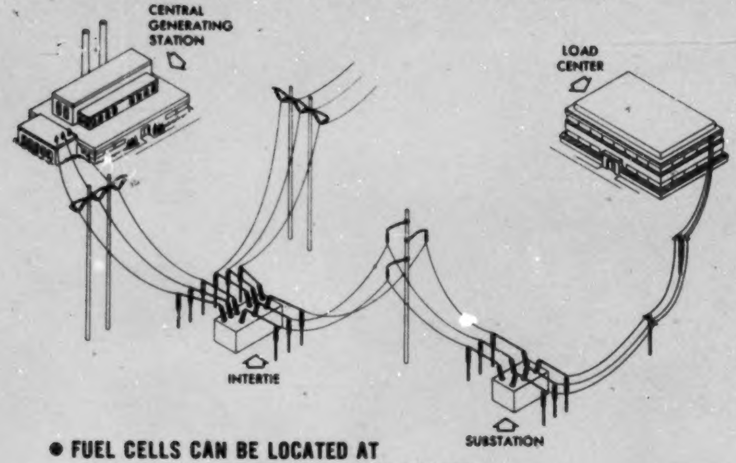
would reduce the need for new high voltage transmission lines as well as new fossil fueled, central generating stations. In addition, electrical losses associated with transmission are eliminated.



Location at a load center would eliminate the need for distribution lines and equipment as well as transmission lines. In this case electrical losses associated with both transmission and distribution are eliminated and there is the possibility that some of the fuel cell waste heat can be utilized at the load center to provide hot water, space heating and adsorption cooling.

SITING

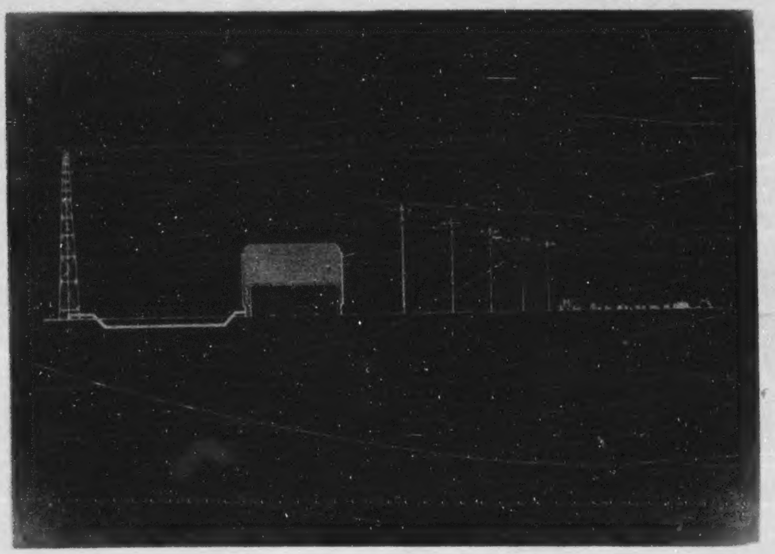
FUEL CELL APPLICATION OPTIONS


CENTRAL GENERATING STATION
LOAD CENTER
INTERTIE
SUBSTATION

- FUEL CELLS CAN BE LOCATED AT OPTIMUM SITES IN THE UTILITY SYSTEM

So, on-site locations of modest size fuel cell powerplants . . . .

and dispersed use of large multi-megawatt fuel cells in locations such as substations represent two uses that the gas and electric utilities consider acceptable and are supporting.



The benefits are many.

FUEL CELL BENEFITS

LOW HEAT RATE
- IN SMALL SIZES
- AT PART LOAD

IMPROVED ECONOMICS
- MINIMIZE TRANSMISSION AND DISTRIBUTION LOSSES

IMPROVED SERVICE QUALITY
- HIGH AVAILABILITY
- INSTANT LOAD RESPONSE
- SPINNING RESERVE

GREATER SITE FLEXIBILITY - MORE SITES BECOME AVAILABLE
- LOW POLLUTION
- NO WATER REQUIRED
- GOOD AESTHETICS
- LOW NOISE

REDUCED CAPITAL REQUIRED
- CAPACITY INSTALLED IN PHASE WITH GROWTH
- TRANSMISSION AND DISTRIBUTION INVESTMENT REDUCED
- NO STACK CLEAN-UP EQUIPMENT REQUIRED

REDUCED LEAD TIME
- FACTORY ASSEMBLY AND TEST
- MINIMUM FIELD CONSTRUCTION

Let's turn back to fuel cell fundamentals for a moment to review the three major components required for commercial fuel cells using hydrocarbon fuel – the fuel processor, (or reformer) the power section and the inverter.

This is a photo of an experimental fuel processor which utilizes a conventional steam reforming process used by the petro-chemical industry. Our task has been to develop lighter, more compact and cheaper fuel processing equipment having both higher efficiency and load following capability. (The reformer is on the left and the shift converter on the right.)

FUEL CONDITIONING

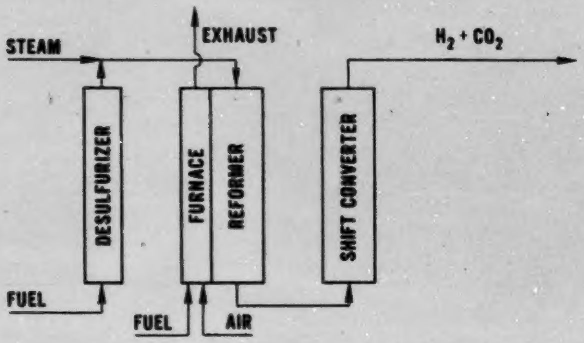
PROCESSES DEVELOPED AND USED BY PETRO CHEMICAL INDUSTRY

- STEAM REFORMING
- PARTIAL OXIDIZING
- HYDROCRACKING
- HYDRODESULFURIZATION

This is a schematic of the fuel processing component. First sulfur is removed; then the hydrocarbon fuel, methane, in this example, is broken into hydrogen and carbon monoxide in the steam reformer. This is a catalytic process involving heat, steam, fuel and nickel catalyst. The carbon monoxide is changed to carbon dioxide by the addition of steam in the shift converter and additional hydrogen is formed from the steam. The fuel processor thus delivers hydrogen and carbon dioxide to the fuel power section.

Satisfactory steam reformer performance has been demonstrated and we are now working to reduce the equipment cost and broaden the fuels capability.

STEAM REFORMING PROCESS



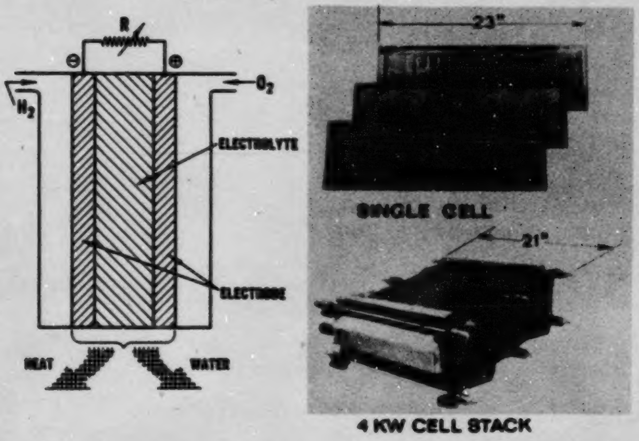
REFORM REACTION _ $CH_4 + 2H_2O + HEAT \rightarrow 3H_2 + CO + H_2O$

SHIFT REACTION ____________________ $CO + H_2O \rightarrow H_2 + CO_2 + HEAT$

OVERALL REACTION _ $CH_4 + 2H_2O + HEAT \rightarrow 4H_2 + CO_2$

The fuel cell power section consists of multiples of single cells, each cell consisting of an anode, electrolyte, cathode and plates that collect the current, bring the fuel gas and air to the reaction sites, and provide for the removal of waste heat and water. At the anode, electrons are stripped from hydrogen creating hydrogen ions which migrate to the cathode. The electrons travel through the external load to the cathode, creating oxygen ions which combine with the hydrogen to form product water. It is the flow of electrons through the external circuit which produces the useful DC electrical energy.

FUEL CELL CONCEPT

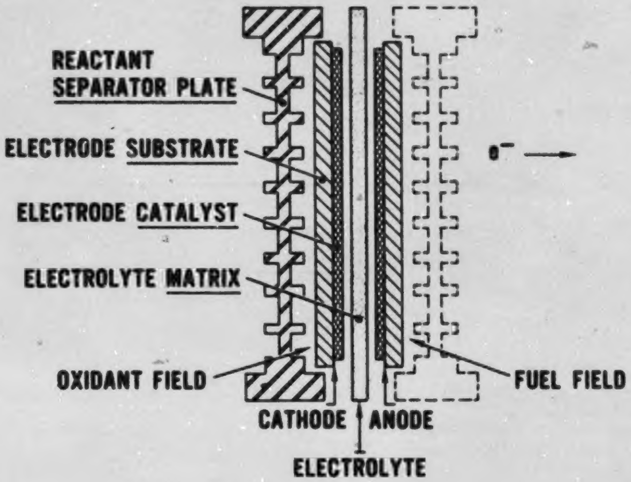


4 KW CELL STACK

An exploded view of an electrode looks something like this, although the combined thickness of the electrodes and electrolyte matrix in the actual hardware is less than 1/16 of an inch.

ACID FUEL CELL ASSEMBLY

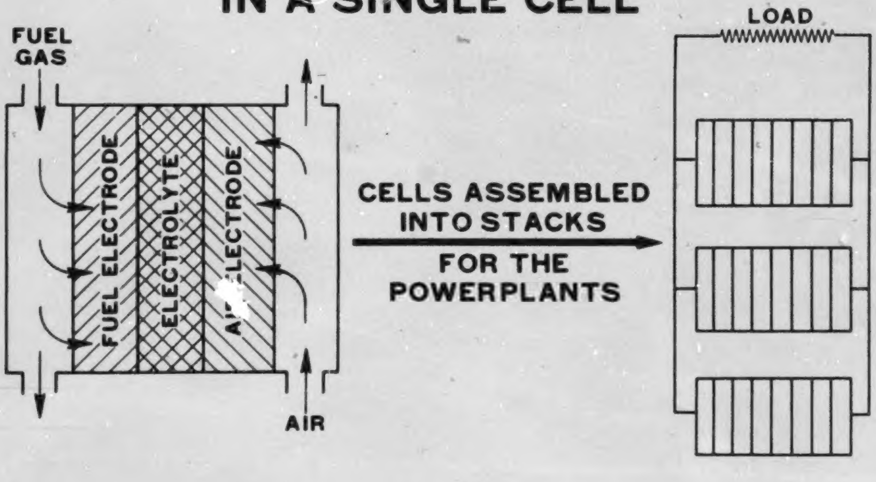
SIMPLIFIED SECTIONAL VIEW


REACTANT SEPARATOR PLATE
ELECTRODE SUBSTRATE
ELECTRODE CATALYST
ELECTROLYTE MATRIX
OXIDANT FIELD
e⁻ →
FUEL FIELD
CATHODE
ANODE
ELECTROLYTE

Each cell produces less than one volt so that cells must be stacked in series to obtain practical voltages and these stacks joined in parallel to provide higher power output.

FUEL CELL

PROCESS TAKES PLACE IN A SINGLE CELL

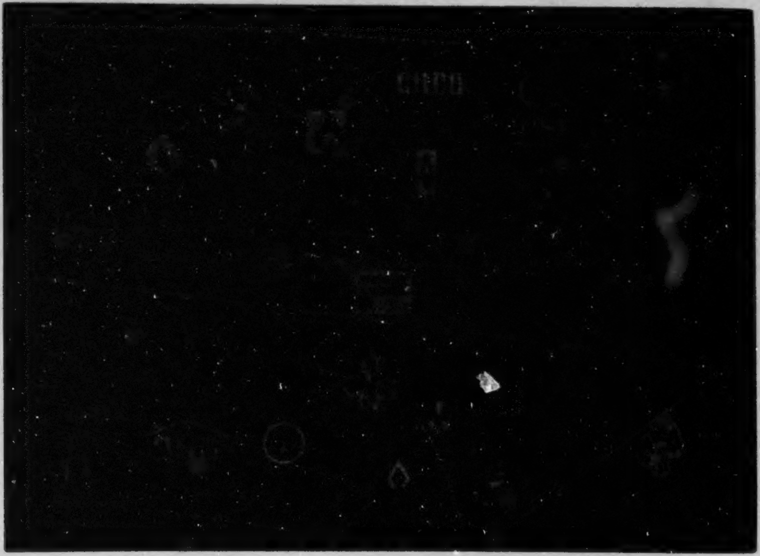

FUEL GAS
FUEL ELECTRODE
ELECTROLYTE
AIR ELECTRODE
AIR
CELLS ASSEMBLED INTO STACKS
FOR THE POWERPLANTS
LOAD

A major thrust of the cell research effort has been to bring the catalyst cost down to an economically viable level. This objective has been achieved. Further improvements in cell performance, decay, and process cost are desirable. A 100 cell stack used for experimental testing is shown here.

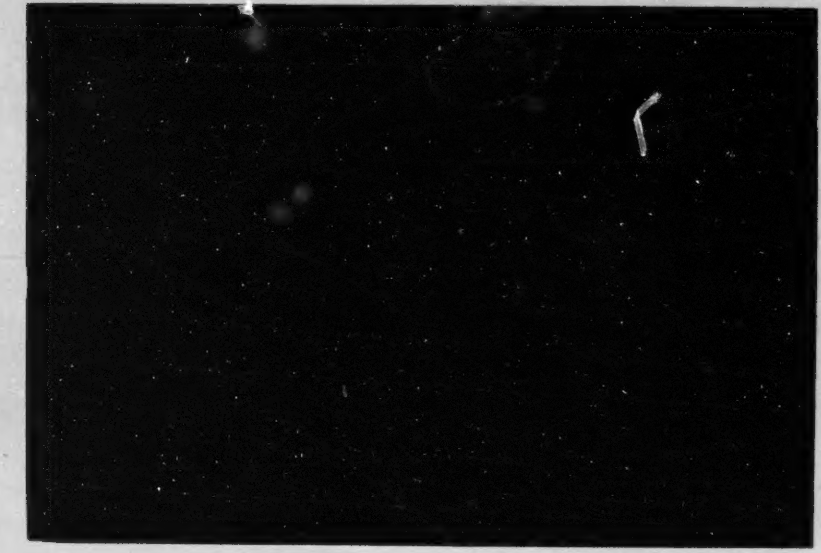
FCG-1
100 – CELL
ASSEMBLY

Inverters are needed to convert the DC electricity generated by the power section to AC because we live in an "AC" world. Power Utility Division and their suppliers have concentrated on advancing solid state inverter technology and the progress has been excellent. Efficiency of small inverters is now on the order of 90% and of large inverters on the order of 95%. Weight and size have been reduced dramatically as reflected by the recent experimental inverter shown on the right. (Each of these inverters have about the same output.)

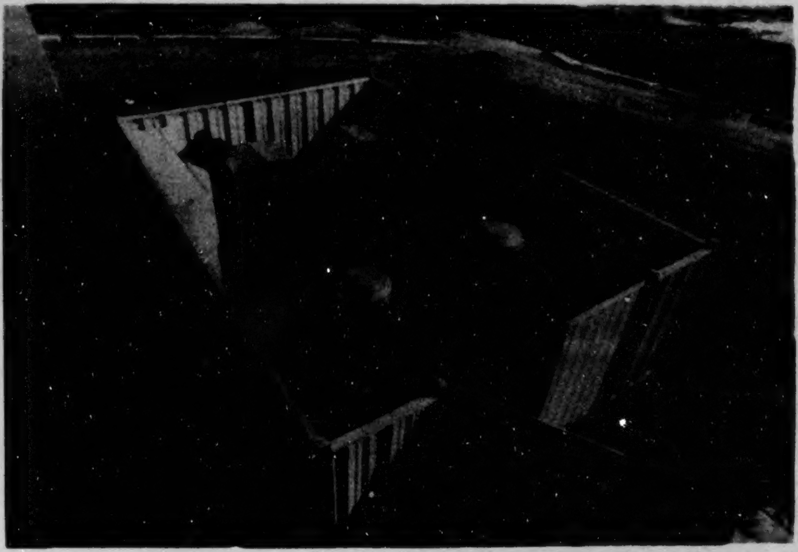
Turning now to our two commercial fuel cell program activities – over the past 7½ years a group of some 38 investor-owned natural gas companies, together with Power Utility Division have participated in a program known as TARGET to investigate the feasibility of fuel cells for on-site use . . . .



where all the needs of the building including heat, hot water and electricity would be supplied by natural gas delivered by underground pipe.

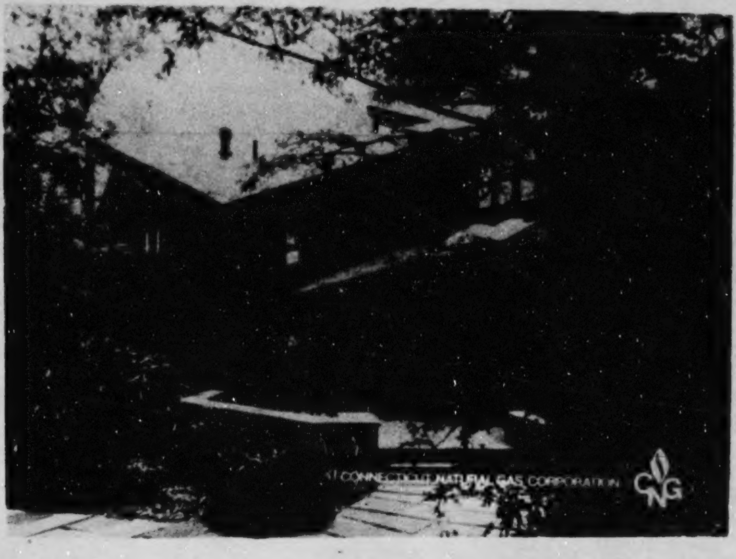


In order to obtain real life data some 65 experimental 12.5 kilowatt powerplants were installed in a variety of buildings in . . . .

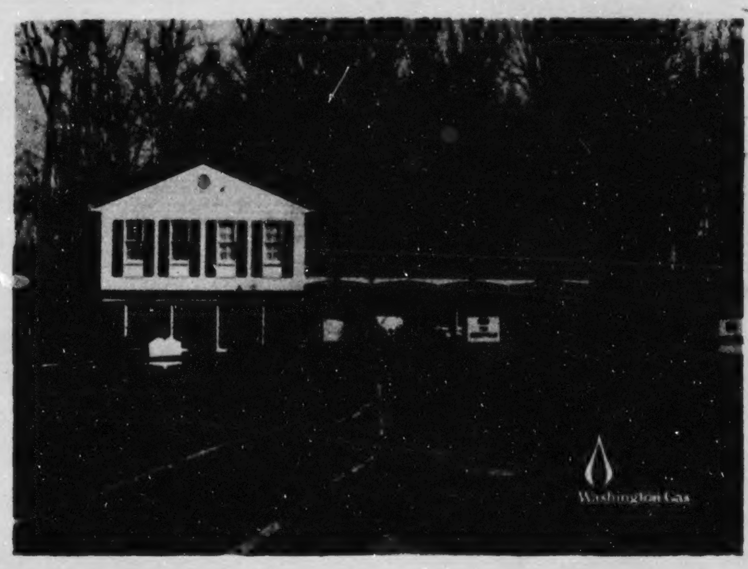


in 17 states, Canada and Japan. These units demonstrated the on-site fuel cell powerplant energy service concept in varied environments.

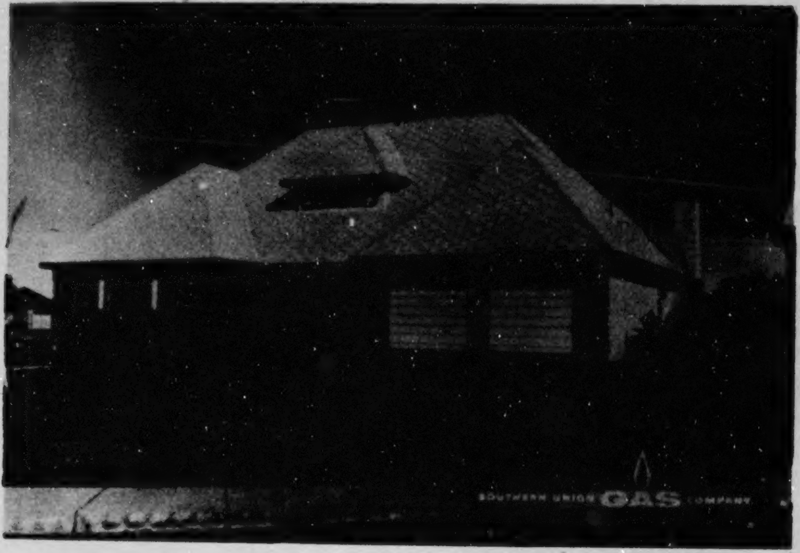
The initial natural gas experimental fuel cell powerplant was installed inside this Farmington, Connecticut condominium.


CONNECTICUT NATURAL GAS CORPORATION
CNG

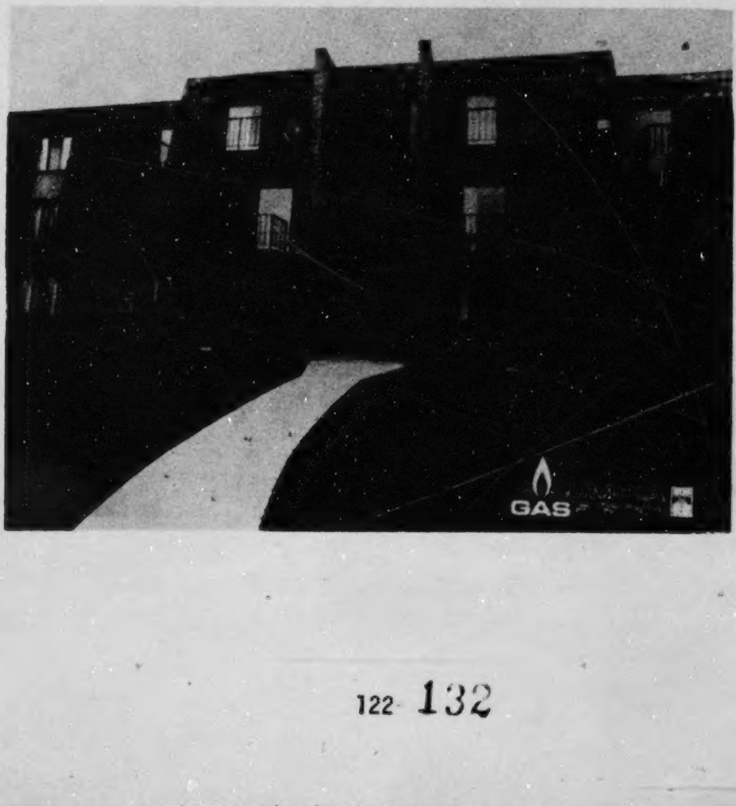
Other experimental fuel cell powerplants were evaluated in homes across the country, such as this model house near the Nation's capital in Washington.


Washington Gas

Operation at high altitude was tested at this home in New Mexico.

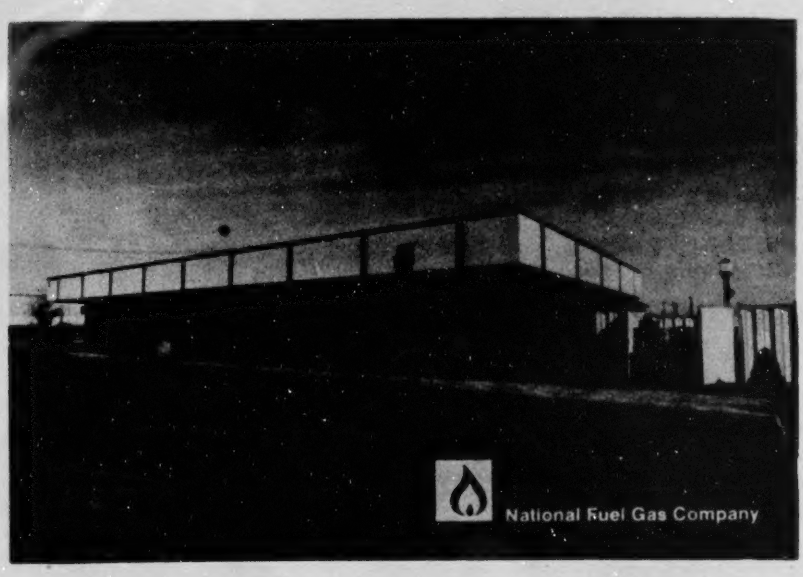


Multi-unit apartment dwellings presently served by natural gas are considered particularly attractive for fuel cell installations as all the energy needs of the complex are supplied by a single underground utility source, natural gas.



Electricity for this industrial building in Ohio was supplied by three powerplants operating in parallel.

Other applications include commercial banks; this one in Buffalo, New York . . . .


National Fuel Gas Company

and another in Cleveland, Ohio. This field test program has confirmed the feasibility of the on-site fuel cell concept and has provided a valuable learning experience for the gas industry and Power Utility Division. If the on-site fuel cell research and development program continues to advance the technology, the first of a family of 20-250 kilowatt powerplants will be placed in service late this decade.

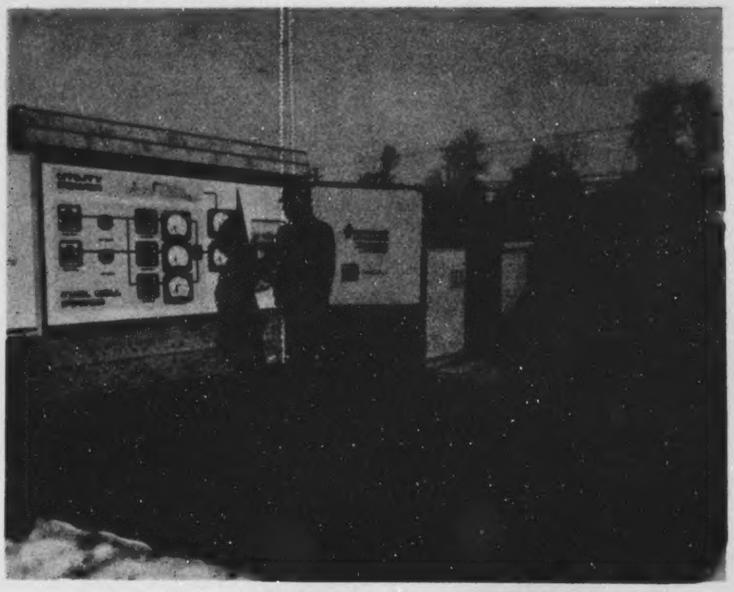
Consolidated Natural Gas

Testing in electric utility substations in Northern New Jersey . . . .

PARALLEL OPERATION

PUBLIC SERVICE ELECTRIC AND GAS INSTALLATION

and in Connecticut . . . .



demonstrated the low noise, low emissions, high quality electric service and other qualities of the fuel cell important to electric utilities.

ELECTRIC UTILITY DEMONSTRATIONS WITH TARGET POWERPLANT

- SPINNING RESERVE
- LOAD DISPATCH
- UNATTENDED OPERATION
- PART POWER AVAILABILITY
- GAS TURBINE HEAT RATE
- UTILITY QUALITY POWER
- SYNCHRONIZATION WITH UTILITY LINE
- FAULT RECOVERY
- MULTIFUEL OPERATION
- PARALLELING ON DC BUS
- AIR POLLUTION LEVELS LOWER THAN GOVERNMENT STANDARDS

These demonstrations and feasibility studies of dispersed fuel cells have convinced nine major electric utilities of the usefulness of a large fuel cell electric generator.

FCG-1 PROGRAM SPONSORS

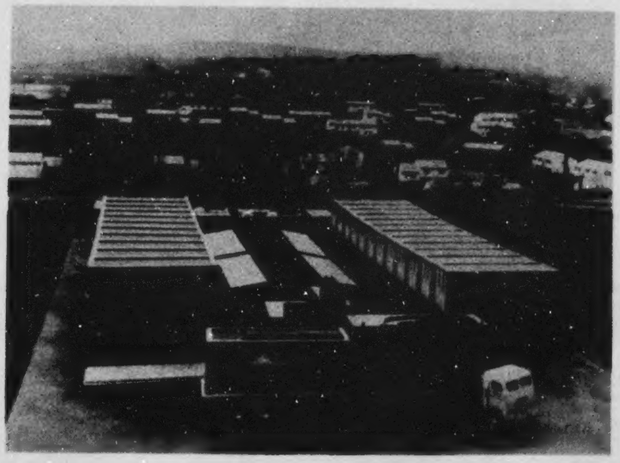
- **BOSTON EDISON**
- **CONSOLIDATED EDISON**
- **CONSUMERS POWER**
- **NEW ENGLAND ELECTRIC**
- **NIAGARA MOHAWK**
- **NORTHEAST UTILITIES**
- **PHILADELPHIA ELECTRIC**
- **PUBLIC SERVICE ELECTRIC & GAS**
- **SOUTHERN CALIFORNIA EDISON**

- **PRATT & WHITNEY AIRCRAFT DIV.**

Here is a model of the 26 MW powerplant being developed for these electric utilities by Power Utility Division. This powerplant, called the FCG-1, is a completely automatic electric generator, constructed of factory assembled and tested, truck transportable sub-modules. The powerplant is air cooled and has a competitive heat rate with the most advanced conventional powerplants at rated load and a superior heat rate of part load. Each 26 MW powerplant will be capable of serving the electrical needs of 20,000 people.

Conditional orders for 56 FCG-1 powerplants have been received with deliveries scheduled to start late this decade upon confirmation of these orders.

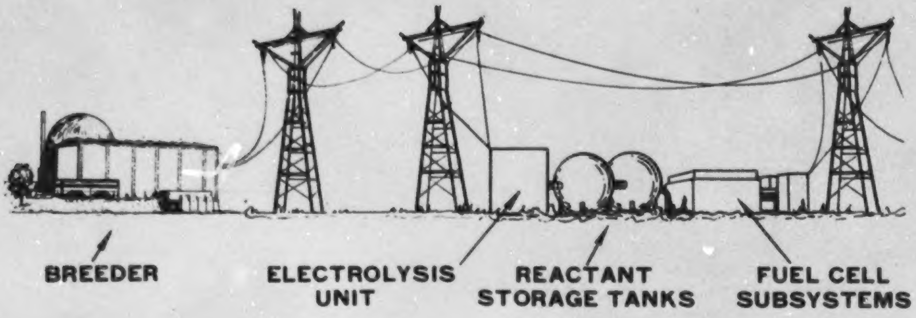
FCG-1 INSTALLATION



The electric utilities and the government are also investigating the use of fuel cells as an element of energy storage systems that could store large quantities of energy. In this option, off-peak nuclear or solar generation provides electric energy to electrolysis units to convert water into hydrogen and oxygen. When needed, the hydrogen fuel is converted back to electric energy by means of a fuel cell powerplant. This energy storage concept requires only one percent of the land area needed by conventional pumped hydro-storage systems. Additionally, the environmental and operational features of the fuel cell would permit it to be located close to the load site.

FUTURE USES

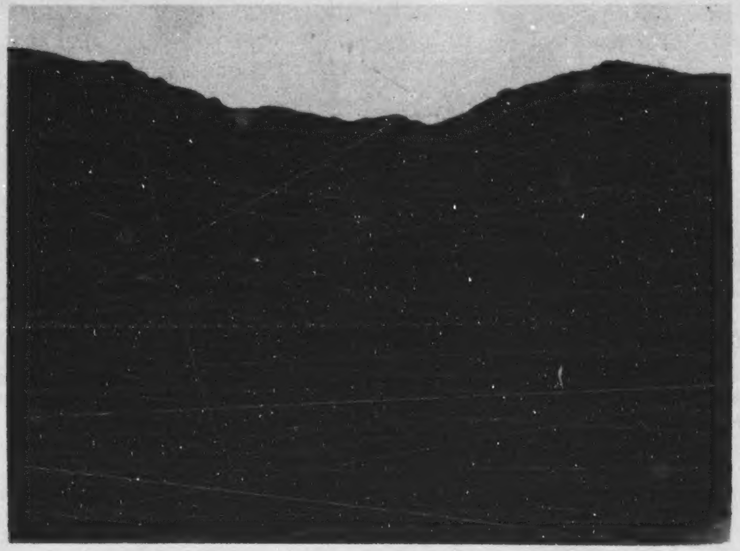
ENERGY STORAGE WITH FUEL CELLS ENHANCES CENTRAL STATION UTILIZATION



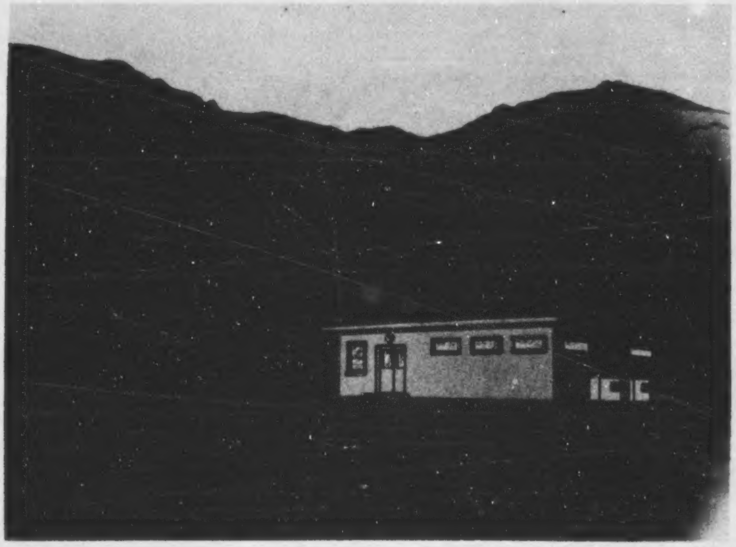
Apart from utility applications there are many potential uses for fuel cells. For example; there are many nations and areas scattered across the globe that are just beginning to develop.

DEVELOPING NATIONS

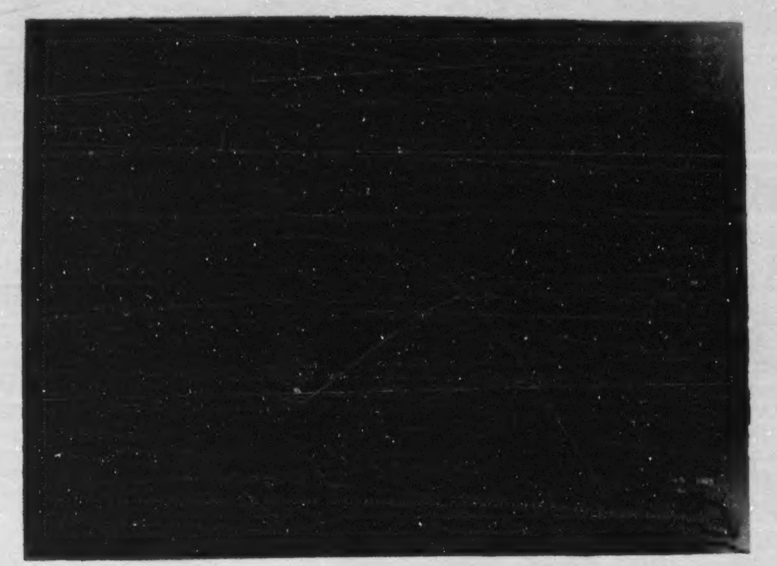
Within these developing countries, there are countless villages without electric power. Many of these areas are so financially poor, that they could ill afford a central generating plant for their modest electrical needs.



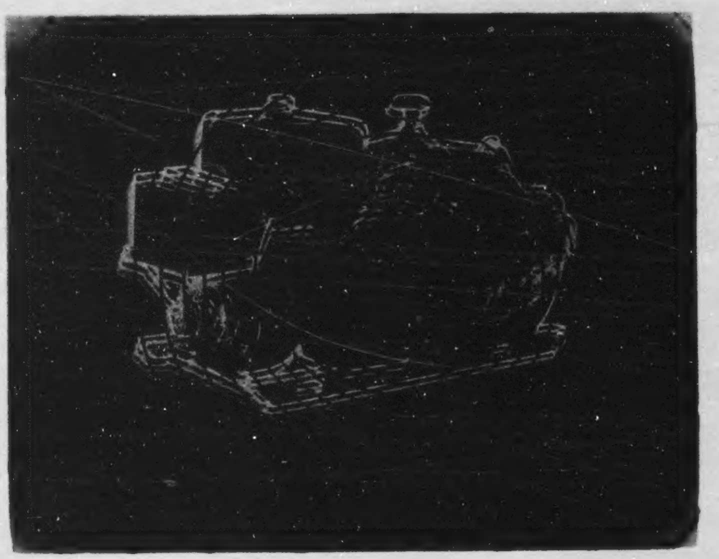
The early requirements of such a village might include a medical and communications building, and, as shown here, modular fuel cell powerplants could be utilized to meet these initial power needs efficiently and without a large capital outlay.



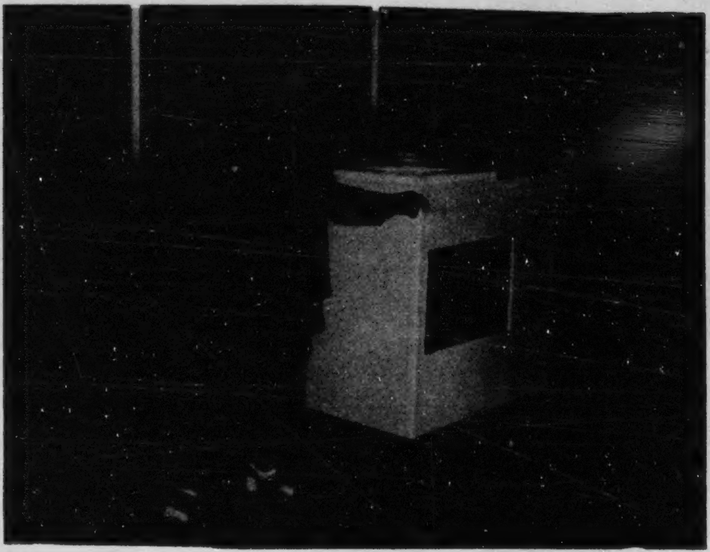
As the village develops, requiring additional power for government, education, commerce, and industry, fuel cell powerplants could be added in modules to match the growing need.



Another use for fuel cells is general purpose power, now being served by gasoline and diesel engine-driven generating systems, which produce air and noise pollution as well as vibration.

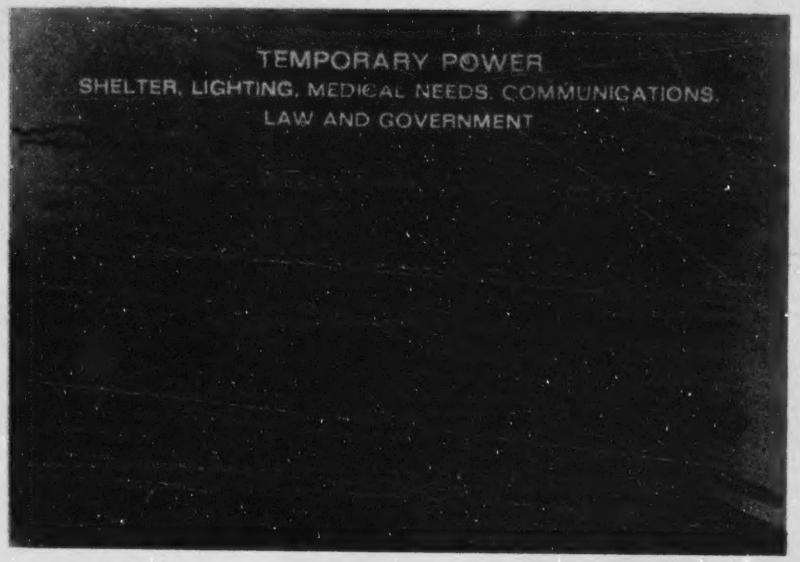


Far kinder to our environment, are fuel cell powerplants.



Uses might include agriculture . . . .

construction . . . .


TEMPORARY POWER
SHELTER, LIGHTING, MEDICAL NEEDS, COMMUNICATIONS,
LAW AND GOVERNMENT

and remote places, such as islands.

Further, the fuel cell seems to be especially compatible with our nation's desire to keep our natural recreational areas free from noise and pollution.

These many non-utility uses can be expected to follow on the heels of successful utility introduction. Ultimately fuel cells can be expected to impact favorably on the nation's balance of trade as they enter the export market.

Commercial fuel cells are emerging as a new and desirable form of power generation having high environmental and conservation value. They have been nutured thus far by private funds. Clearly, they merit attention and support of the Federal Government.

OVERALL PROGRAM

- **MOMENTUM IS HIGH**
  - PRIVATE FUNDING THROUGH - 1975 - $75 MILLION
    - UTILITY INDUSTRY SHARE - 60%
    - UNITED AIRCRAFT SHARE - 40%
- **PROBABILITY OF TIMELY INTRODUCTION OF FUEL CELL WOULD BE SIGNIFICANTLY ENHANCED BY FEDERAL FUNDING SUPPORT**
- **WITH ADEQUATE FEDERAL SUPPORT FULL OPERATIONAL BENEFITS OF FUEL CELL COULD BE DERIVED BY 1980**

Cutting Down on the Energy Demand

REDUCING ENERGY DEMAND

George Reeves, Manager, Long-Range Planning
Electric Energy Association

The Electric Energy Association (EEA) is the same thing as the Edison Electric Institute (EEI). It is a trade association of investor-owned electric utility companies. Investor-owned means that we've got stock on the stock market, and so forth. There are lots of different trade associations for the electric utility industry, and they all started out a long time ago as the Association of Edison Illuminating Companies and they all conglomerated. Then, about 15 years ago, somebody said well, let's go down to Washington and lobby with the Federal Government, and somebody else said let's have a trade association do that. But somebody else said, well, we can't because they are tax free, and if we lobby then we can't do that. So they said alright, let's form another trade association.

About twelve years ago, somebody said let's go sell electric heat. We can make a lot of money if we sell electric heat. Somebody else said, well, I don't want to do that because my electric company sells natural gas as well as selling electricity. And the first guy said well, that is too bad. I'm going to form another trade association and sell electric heat and so forth and so on. Let's do image advertising. Look how nice your friendly local electric utility company is. And somebody said we don't want that trade association doing that because they are really a bunch of committees, and they don't know anything about that, so let's form another trade association.

Electric Energy Association was formed out of a merger of all of the trade associations that relate to the consumer in the electric utility industry including the organization that was trying to sell electric heat and the organization that conducts educational programs which was the Electrification Council, the Electric Vehicle Council, which tries to do research on electric cars and stuff like that, and when we were formed (which was about three years ago) our major purpose was to get out there and sell some electricity. The world has changed in three years, rather radically as far as the electric company is concerned, and we find that our association is the only national group in the electric industry that has a knowledge and a function that relates to the consumer. So we get the consumer-related activities such as energy conservation. O.K., that is what EEA is.

I am manager of long-range planning for the Electric Energy Association. That means I figure out what we are going to do for lunch tomorrow when we are in the office. I was very glad to see that there is a bunch of young people getting involved in long-range policy. One of the classics that bothered me no end before I was manager of long-range planning was a few years ago Westinghouse Electric decided that its super top executives would cease their active functions at age 60 instead of 65 and for the remaining five years of their corporate life there would be a special long-range planning board. I don't know about you, but these guys aren't going to be around twenty years from now. I'm going to be around twenty years from now; you are going to be around twenty years from now; and it's up to people who are less than 65 years old to do the long-range planning.

We tend to view what Dr. Bauer of the Federal Energy Administration was talking about, the influence of the government, and the fact that the government has to deal with constraints and institutions in the private sector and try to move them in the direction they would like to go, and try to move them, sometimes, in directions they don't like to go. Of course, coming from the private sector, we view it a little bit differently. We tend to view the Federal Government as a constraint, and we would like to move in directions that they don't want to go. But, I heartily agree with something that he kept saying and repeating: that we cannot take any one aspect of our life and make that a prime cause. We cannot say right now energy is the only basis for making a decision. We, in the opinion of a lot of people, went a little bit too far too fast in environmental constraints. A lot of what the Environmental Protection Agency (EPA) has done has caused a lot of the "energy crisis."

I also heartily endorse the concept that the energy crisis is not a short-term item. We have ended the era of cheap abundant energy, and we may never get back there again. Let me toss out some numbers for you, and if you are interested you can write them down. They are really available in lots of other places. You have probably got them in other material. The energy supply of this country currently is roughly 46% oil, 32% natural gas, 17% coal, 4% hydroelectric, and about 1% nuclear. One of the important things that I'm sure other people have touched on, but I want to reiterate, is that coal, which is our most abundant domestic source of energy, is only 17% of our supply. Natural gas and oil which are our least abundant resources, are 73% of our energy usage.

If we are not really using that much natural gas and oil then why are we worried about reducing consumption or slowing the demand growth rate? We've got some problems. One of which is the Federal Government. The Environmental Protection Agency, said in essence to a lot of utility companies: you can't burn coal, it's dirty; or, you can't burn high sulphur crude oil, it's dirty. So we shifted a lot into low sulphur oil, natural gas and tried to shift into low sulphur western coal. Which means strip-mining, which means EPA again. It was very funny for me to see barges going up the Ohio River carrying coal and coming back down empty. They were bringing western coal into Appalachia. You have a situation last winter where the major coal first burned on the east coast of the United States was imported coal, from Poland; and the United States has more coal than anybody else in the world. Maybe it's nice that we get the Polish miners to get black lungs instead of the guys in Appalachia.

We have had problems in nuclear plant sitings. Nuclear plants are running up to 8, 9, or 10 years from the time somebody says go until the time it's on line. This means that we are all behind the capacity of our generation. Hydroelectric power is a real nice fuel except that there aren't that many rivers left where we can stick dams up. And contrary to popular belief, the electric utility industry does not want to plus the Grand Canyon.

We have another problem that makes us want to work to slow the demand growth rate and that is, that the electric utility industry historically has a much faster growth rate than the total energy of the United States. Total energy consumption of the United States has been growing at around 6 to 7 percent per year, and electric utility industry has been growing at around 10% per year. That means that we double every 7 years. That means from now until 1981, we are going to have to build as much electric generation capacity as we now have.

Now that used to be fun when we could build a power plant for around $100 or $150 a kilowatt, and we could provide the fuel for that power plant at around 2/10 of a cent per kilowatt hour, and we could borrow money at around 3 or 4%. Unfortunately, these days, that isn't true anymore. We need cooling towers instead of using lakes and rivers. We need stacked gas exhaust cleaners. We need clean fuel. We need a lot more safety; we're going into nuclear which is more expensive to start with, and we find ourselves building power plants that cost

$800 per kilowatt. We find ourselves using fuel that costs 2 1/2¢ to produce a kilowatt hour, and we find ourselves paying 15% for money, instead of 4%. By the way, when you hear that the prime rate is 12%, that doesn't mean you get money at 12%. Because when you go borrow at the prime rate, Chase Manhattan says, O.K. here is a million bucks, and I want you to keep 100 thousand in the checking account, which doesn't draw any interest. So, you only get $900,000 but you pay 12 1/2% on a million. The most costly component of electricity is money.

Electric utility industry sells in one year only 1/4 of its asset value. In other words, if we have a million dollars worth of plant it's only going to sell $250,000 worth of electricity this year. In contrast, with most industries where the ratios are exactly the opposite, it takes them $250,000 worth of plant to make and sell a million dollars worth of stuff each year. The cost of money and the cost of power plants is a highly significant constraint on the cost of energy as sold by the electric utility industry.

Electric rates have been sky rocketing, which brings me to another problem. Up until about five years ago, all electric utility companies except those in Texas are subject to the Federal Power Commission, the reason the ones in Texas aren't is because they carefully avoid crossing state lines and most electric utility companies are regulated. And we have a very vivid example of a regulated private industry in front of us in this country in the railroad industry, and I submit to you that in 20 years if somebody smart doesn't figure out something we are going to say the railroad industry and the electric utility industry in the same breath; because the electric utility industry has big problems, with money being the major one.

Up until five years ago, we kept building bigger and bigger plants and making them more efficient and getting economies of scale and doing all kinds of nice things so we would go in front of the public utilities commission once a year or once every two years, something like that, and say: "Pardon me, commissioners, would you mind if I lowered my rates for electricity?" And they would carefully deliberate and eventually come back and say, "Yes, you can do that." Well, about five years ago, one power company went to its public utility commission and said, "We have to raise the rates," and low and behold if the utility commission didn't answer them within one month and say, "yes you may." They ansered them about a year-and-a-half later and said, "Half." And all of a sudden, the electric companies found out what regulatory lag means when it is working the other way, when it is not making money for the electric companies, but hurting like mad.

Electric companies have been trying to raise their prices at a fantastic rate, and to raise their prices in a forum that is political. Public utility commissioners hold political open hearings on every rate case; and if you don't think that this is an institutional constraint to reasonable pricing of energy, well it is. We have in addition been internalizing a lot of the costs that did not appear as cost of energy. For example, the cost of a miner getting black lung. To some extent it is now reflected in the price of coal. We have a mine safety act and the price of coal is now reflected in the cost of electricity. Ditto for the fact that we put up cooling towers instead of warming up the fish.

That reminds me of two stories. Commonwealth Edison Company, which is approximately 95% coal and nuclear plant, built a very nice plant about 1/2 way down Illinois. They built a huge lake to cool the plant with, and they stocked it with fish and all that stuff, and planted trees and built a nice park, and people used the park and went motor boating and swimming and so forth. About five years ago, Commonwealth Edison Company said: We could save all the taxes on all this land if we gave it to the state for a park. They did and the state said stop thermally polluting our park. In North Carolina, the state commission who controls lakes controls anything over ten acres--man-made, artificial, or natural. The utility in North Carolina, not Duke Power Company, but Carolina Power and Light, now owns a very nice large dry lake, because they didn't realize that once they went over ten acres on their cooling pond, that the state would say that you can't thermally pollute that lake. I have a fairly good friend who owns a motel on that dry lake so if you ever want to go swimming in a dry lake some day...

There is a nuclear power plant in New Jersey called the Oyster Creek Plant, that has the honor of being the only utility company power plant to be successfully sued for stopping thermal pollution. They shut off the power plant in the middle of the winter and the Manhattan died (a trash fish that lives in warm water), and these guys were breeding around the outfall of the nuclear power plant, and when they shut down the plant for maintenance the fish died. What happened was that the state of New Jersey said that those fish are worth a $1 each, you have to pay us. The brilliant utility company fought the suit on the basis that the state didn't own the fish. However, I am happy to report that it all worked out nicely in the end because the utility company came up with a plan that accomplished both goals. They built another nuclear plant there, and they were only going to shut down one at a time.

Well, we have got a lot of customers complaining about the price of electricity, and I said before, it is not going to go down. There are two things that could lower the price of electricity, or lower the rate of increase: (1) a lowering of the cost of money. I don't see that happening. (2) Either a lowering of the price of the fuels or a massive shift to nuclear power. I don't see either one of those happening in the next ten years. So, we do have some interest in energy conservation. We don't like customers yelling at us. We don't like necessarily going out into the bond market trying to pay 15% for bonds and having them say no. And then we can't build the plant, and then somebody turns on his air conditioner, and we don't have the electricity, so we lower the voltage by 3%, and then somebody yells about the blackout.

Fortunately, we have a history in the electric utility industry on the utilization end of energy conservation. Lo and behold we found out that we are nice guys. Why are we the nice guys? We have the high-priced fuel. It's a processed energy form, and it sells traditionally at 1 to 2 cents per kilowatt hour (now I'm talking about back 8 to 10 years), which is 3,400 BTU's as compared to something like 20¢ per gallon of gasoline which is 140,000 BTU's. It is much more expensive than even gasoline, way more expensive than natural gas or diesel oil or #6 oil. So, when we went out and tried to sell, for example, electric heat, when someone was paying $50 to heat his house for the whole winter, and we figured out what it would cost for electricity; we went to the guy and said, O.K., it is going to cost you about $639 to heat your house with electricity for this winter. Please buy our system. It didn't take many of these calls for us to figure out that this was not the way to sell electric heat. So then we said, well, look, the electric system is cheaper than this big old oil burner, anyhow, why don't you take some of that extra money and put it in storm windows and insulation and seal the cracks, and that will only cost you $250 to heat with electricity. And lo and behold, we started selling some.

When I talk about selling electric heat, I must point out that we are in Tennessee Valley Authority (TVA) land right now, and the Tennessee Valley Authority, over 40% of the residential units are heated by electricity. Whereas, nationally, 7% are heated by electricity and that 7% includes the 40% here in Tennessee. We found when we went into commercial establishments, office buildings, and shopping centers that in order to sell electric heat, or electricity as an energy source we had to sell a lot less of it from energy content than the other guy was trying to sell in order to be competitive.

Let's break down energy in terms of the end uses, so we can see where we can make an impact. First of all, 41% of the energy used in the country is used in industry, 14% in commercial establishments, 19% in residential, and 26% in transportation. There isn't too much electric transportation, so let's forget about that one right away. When we break down the rest of the stuff, we find that in residential, commercial, and industrial energy drives (like a motor in industry) steam, processed heat, and things like this, use about 37% of the energy in this country. Space heating requires about 20% of the energy in this country, air conditioning about 2 1/2%, water heating about 4%, all others under 10% total. Notice that air conditioning requires 2 1/2% of the energy used in this country. Now, that is like nothing. Air conditioning is one of the major causes for the increase in the price in electricity.

The major cost factor of electricity is the size of the power plant. The size of the power plant is determined by how much electricity we have to put out at any one instance in time. And typically, with most electric utility companies that time occurs around three in the afternoon on the hottest day of the summer, because there have been a couple of hot days before that and it's an air conditioning load. That is in, say, August, that we have to put out that many kilowatts. We also have a lower peak on the darkest day of the year, December 21, when everyone comes home, puts on the lights, turns on the Christmas lights, starts cooking, drawing hot water, taking a shower. In the middle of the night we use a lot less energy, and over the year in the spring and the fall there is a lot less energy required.

The number of kilowatt hours sold determines the cost of the fuel to us, which is a small component of the price of electricity, or historically has been. But, the size of the peak determines the cost of the money that we have to pay to build the power plant, so what we try to do is sell electricity, for example, electric heat, which typically is used in the winter, and more of it is used when the sun isn't shining on the house. Electric heat is a great load. We don't sell any electric heat at all on a summer peak. We don't like air conditioning very much. It is a horrible load. Water heating is a nice great load. I think something that is significant is that air conditioning, which is 2 1/2% of the energy used in this country, is a very major determinant in the cost of electricity to everybody and in the problems of electrical supply, such as blackouts and brownouts.

Let's talk about what we can do in some of the energy uses, starting with existing residential and new construction. For about ten years, we have had an electric comfort conditioning standard and an all electric home program to sell electric heat. The insulation requirements ten years ago that we were promoting are still higher than the new Federal Housing Authority (FHA) requirements. We have been working very closely with FHA for the past ten years to try to upgrade the insulation requirements for a very commercial profit motive. If an oil heated house had to put that much insulation in, it doesn't save them that much on the cost of operation because it's cheaper but it costs them a lot on first costs, so it makes electricity look more attractive.

Appliance usage in a home: electric toothbrushes, clocks and toasters are a negligible use of energy. Not only is it negligible, but we can't do anything about it. Nobody is going to give up their television set. We don't talk about energy conservation; we talk about energy management. What is the difference? It sounds better. Besides that, we tend to view energy conservation as: "Don't use the energy." We view energy management as "get the same job done but use less energy." It is a lot easier to convince people that you can do the same job, using less energy and to implement that than it is to say don't do the job. For example, we could use very high efficiency lighting fixtures in here or we could shut off the lights. Which brings me to lighting.

In the residential area, lighting is somewhere around 20 to 30% of the energy usage. I want to point out that the typical residency of the United States uses 7,600 kilowatt hours per year. There are 3,412.7 BTU's in a kilowatt hour and there are 3,600,000 joules in a kilowatt hour. The unit of power in the metric system is the watt, and the unit of energy is the watt second, which is the joule. What can we do about lighting? Not too much--not in a residential area. First of all, the higher efficiency lights, fluorescent for example, are more expensive, and they are not as pretty as GE softlight, for example, and you meet a lot of resistence when you try to sell that kind of item. The very high efficiency lighting such as sodium mark lamps, things of this sort, are really ugly.

But when I talk about efficiency of lighting I want you to understand that it is very significant. A high efficiency light source can provide the same illumination for around 5 watts as a 100 watt bulb. It is a very significant opportunity if the lighting industry can figure out how to make a high efficiency lamp that is cheap and looks nice.

By the way, the long-life light bulbs achieve their long life by sacrificing efficiency. The next time you're in a store, take a look at the typical light bulb. They are all required to have their light output in lumens and their light estimate in hours. You will find that the long-life light bulb has a longer life in hours, and a lower light output per given wattage than the short-life light bulb. Makes sense...? So, long-life light bulbs are less efficient.

On heating, I mentioned the Federal Housing Authority. We have been working with them to upgrade insulation standards. We have been working with the FEA on projects, such as their project with Fred Dubin on residential booklets on how to operate different buildings. We have been working with existing buildings a great deal. The conversion market to electric heat always requires the addition of insulation so that the guy doesn't go broke the first year when he heats it electrically.

Residential air conditioning is a very, very small energy requirement. The major thing we can do there is improve the efficiency of room air conditioners. Room air conditioners operate on the 7 1/2 amp rule. The national electric code requires that anything that is plugged into an electric circuit (15 amp typical size electrical circuit) that something else can be plugged into, is limited to 7 1/2 amps draw. So, you don't plug six of them in and burn the house down. If we had, for example, to make a 6,000 BTU room air conditioner, we put less copper in the motor and less copper in the coils because copper is expensive, and it would come out using 7 1/2 amps and giving you 6,000 BTU's of cooling. After General Electric did that, Westinghouse said we are going to make an 8,000 BTU unit because we can sell them better. They were limited to 7 1/2 amps. So, that now we get up to about 12,000 BTU's of cooling with 7 1/2 amps. It is more expensive than 6,000 BTU's of cooling at 7 1/2 amps. We can also make 6,000 BTU's of cooling at 3 3/4 amps, but nobody does, because they can't sell it. We get into problems of labeling, legislation, and what is being done now is that the room air conditioning manufacturers are manufacturing high efficiency units and are labeling them so. They are more expensive and they are not selling them too well.

There is another device that we are promoting a great deal of research on and that is called the heat pump. What a heat pump does is when your house loses some heat to the outside so that the temperature drops below 68 degrees because we all keep our thermostats at 68 degrees in the winter, the heat pump takes some heat from outside and puts it back in. It requires electricity to do that, but it does not require as much electricity as the heat you get from outside. At ideal conditions, the heat pump transfers four times as much energy into the house as it uses in electricity. The world is not ideal. Under average conditions, the heat pump transfers somewhere between 1 1/2 to 2 times as much energy into the house as it uses in electricity. What are the problems with the heat pump? They cost more. They are in essence air conditioners turned backwards. They are designed to run a short cooling season. So, we had a lot of failure problems. The electric utility industry went out on a big sales kick for the heat pump ten years ago, and it bonged miserably. The General Electric Company once sold 200 of a particular model heat pump and replaced 600 compressors for the 200 units they sold. GE did not make money on that. What we are doing now is trying to promote the heat pump concept in residential heating in order to improve the "efficiency" of energy usage.

Let's talk about commercial. Commercial energy is somewhere around 20% of the energy used in the country. We find that the energy used in commercial establishments, office buildings, stores, shopping centers, and things of this sort, are primarily for two purposes: lighting and air conditioning.

In the middle of the winter, an office building requires air conditioning. Typical new construction office buildings do not require heating at all until the temperature gets down to 25 degrees outside. Everything above that they require air conditioning, which come to think of it, is a little bit fortunate for us, because air conditioning we can do at 1/2 of the energy for the same amount of heat transfer as heating.

What are we doing there? We have done a great deal of promotion and a great deal of education on systems that, for example, take the heat from the inside areas of the building due to the lighting and the people and transfer it to the perimeter of the building where it is needed. Why have we done this? Because we have the high price of fuel. We want to use less in order to be competitive. All commercial establishments require the introduction of outside air for breathing purposes. We used to call it fresh air by the way. Obviously, if you bring in the outside air at 20 degrees, and it is 75 degrees inside, you have either got to heat it to 75 degrees or make everybody very uncomfortable. But, at the same time that you bring in this air at 20 degrees, you are blowing out a lot of air at 75 degrees. There are devices that take the heat out of the 75 degree air and put it in the 20 degree air; or in the summer, take the cool out of the 75 degree air and put it in the 95 degree air. They also transfer water. A big problem in the summer is humidity control.

Insulation is not a particularly significant thing in commercial establishments. There typically is not much wall; there is a lot of glass. Glass is very important. You can reduce the heat transfer through glass by a factor of four, simply by going to double glazing. You can reduce the solar heat gain on glass enormously by using reflective coatings.

You've got a couple of problems there. I can think of three real fast. The John Hancock building in Boston--that's about five actually. They did that before they figured out how to make the reflective coating on the outside of the glass not wear off, so they put it on the inside, which gave different stresses to the two layers of glass, and it all fell down. That is one problem. Another problem you have, of course, is that it is more expensive. Another problem is that it reduces the solar heat in the winter as well as in the summer which costs more energy then to heat the building. Another problem faced by a guy in Dallas is that he put up this nice reflective glass building which is shining the solar energy into the building next door, on the north side of the building next door, where the guy does not have enough air conditioning. Yes, he is being sued.

The Electric Energy Association has developed a very sophisticated model of energy usage applicable to commercial and to some extent industrial, primarily space conditioning usage, and it is called ACCESS. This program, it's a computer simulation, and it's the only public program that does what it does. And by public, I mean the entire engineering logic of the program is available for inspection by anyone and the use of the program is available to anyone. We have already given this program to the National Bureau of Standards, and they are using it in their energy work. NASA also is using it.

NASA, by the way, is involved in a massive effort to not go out of business which is called bringing the technology down to earth, i.e., find jobs for all these engineers. One of the things they are doing is working with the department of Housing and Urban Development (HUD). I was at a convention in Montreal and Jerry Laton, the Director of Utility Research at HUD, stood up and said, "Jerry Laton from HUD" and somebody yelled out, "what's a HUD?" HUD has a concept called Modular Integrated Utility Systems (MIUS). The following remarks are my personal opinion only. It is based on the concept that if you take all our utility problems, electricity, heating, cooling, solid waste, liquid waste, water supply and take them all and role them into one great big package and then sell it off the shelf modually then they all go away. So HUD gave a big contract to NASA and the National Bureau of Standards to research this and the electric industry is helping them to research this.

The heat pump is particularly applicable to commercial establishments. For example, running through the ACCESS program in an office building one time, we designed a system like so--instead of burning something in the building inefficiently to provide heat, and running an air conditioning system, we have heat pumps that extract heat from water located in every space in the building. These heat pumps also provide cooling by putting heat back into the water for a large portion of the year. The heat they take out is comparable to the heat they put back in. So the only energy used in the building is the electricity required to run the heat pump. In addition, we have storage devices. So that they put back more during the day when they are cooling the building, and they can take it out at night when they need heat for the building. We are reclaiming the heat from the exhaust air in that building; we are lowering the volume of the supply air requirement when you don't need as much cooling; and in addition, we are taking the heat from their computer center which is in a different building (which requires air conditioning all the time) taking that heat and plugging it into the new building when required. All of this results in an energy usage in the building of 1/10 of what it would have been under having a boiler and burning it or just having electric resistance heating and conventional air conditioning. But all of these heat transfer devices as opposed to heat creation devices require electricity to operate.

We have been working very closely with a professional society known as the American Society of Heating, Refrigerating and Airconditioning Engineers (ASHRAE) which has produced the document that Dr. Bauer was talking about on building codes. This was commissioned by the National Council of States of Building Codes and Standards, and it has designed evaluation criteria for energy conservation in new buildings. It was originally produced by the National Bureau of Standards and then taken and reproduced by ASHRAE.

It is a performance standard that is expected to be written into the building codes of several states. For example, the state of New Jersey has already commissioned the Dean of Newark College of Engineering to prepare a training course for local building inspectors on how to insure compliance with this code. It is not a rigid, strict code. It takes into account what we can really do today. For example, it calls for efficiencies--co-efficients of performance on air conditioning of like 3.0 by July 1, 1977 and 3.4 by July 1, 1978 (I'm picking numbers out of thin air).

The last section of this says O.K., you design a building according to all these specs, now you don't like the building you designed. Redesign it, and prove that it uses less energy that way and you can do it. That's why it means performance spec, and the way you prove it is by using assimulation such as the ACCESS program.

Getting into industrial energy usage: most of your electricity used industrially is used to power motors to provide mechanical work. Motors operate at like 95% efficiency. We're not going to effect much savings in electricity there. There are individual programs conducted by electric utility companies with the major industries in their area, and this is on a one to one basis which have already saved like 15% of the energy usage of a given plant, and this is an easily achievable factor.

Transportation is the great energy user in this country. Seventy-five percent of it is by private automobile. What we need is an electric car. What we haven't got is an electric car. The gasoline engine is at best 25% efficient. We add all the EPA stuff on it, and it gets worse. We sit there and idle, we don't idle when we are stopped, we also idle when we have our foot on the brake and that wastes a lot more energy. The electric motor is 95% efficient. Of course, you've got to charge a battery and discharge a battery and things like that. Overall, the inplant on car efficiency of electric drive is around 70%. But there is another nice thing about electric cars; you can put the energy back in when you put your foot on the brake. Instead of building a mechanical brake that builds up heat, you use an electrical brake that builds up electricity back into the battery. An electric car can use enormously less energy than a gasoline car. Why don't we have one? Because we can't squish the electricity down small enough. We've got to put it in lead acid batteries that weigh tons. We can build you a very nice two-horse power Volkswagon. That is about it--I'm exaggerating.

Right now the electric car is suitable for short-haul urban driving, particularly multi-stop urban driving, such as delivery trucks; they are being sold for this purpose. Typically the urban, suburban dweller who does have a second car, for short-haul purposes, would not be in the market for an electric car any anyhow because sometimes he wants to use that car for long-haul purposes or high speed purposes, and an electric car cannot do that. We have had no technological change in the lead acid battery in 60 years. Nobody really cared about it. Yes, we are spending a lot of money on the lead acid battery and other batteries, trying to provide a way to store electricity; but we don't have it yet.

On the long, long, long range, for the big picture, the plan of electric energy, as it concerns energy conservation, is two-fold. We want to ease the country's transition into the all electric economy; 'cause that's where we are going, folks. We are going to run out of fossil fuels ultimately. We want to see if we can do this and retain private industry in the electric business. That's a bigger problem.

Electric companies like Consolidated Edison have stopped dividends. Electric companies have sold their power plants and leased them back in order to use the money they got for the power plant to pay salaries. That's mortgaging your future pretty heavily. It's an open question.

I'd give it a 70% probability that the electric industry is not going to make it as a private enterprise, not under regulation. Can we de-regulate the electric utility industry? Why not? What are the parts of the electric utility industry that make it a natural monopoly? The wires. So we share the wires. A lot of people share COMSAT, why couldn't we have a bunch of electric companies that produce electricity and a bunch of electric companies that sell electricity, and one company that distributes it. It's a possibility.

I think that the electric utility industry management is a little bit too firmly in the warm womb of protective regulation to buy it, and I think that the governments concerned, primarily state governments, wouldn't like the idea either.

The major energy source that we have in the future like 40 years from now is nuclear fusion. Nuclear fusion is what makes the sun work, and the way it is projected to operate is the fuel would be heavy hydrogen of which there is enough in a tea cup of the ocean's water to power Houston for three years. A couple of minor problems with fusion is we don't know if it is scientifically feasible. When we plot the curve and draw it way out it works. But nobody has done it yet. We have got to get the temperatures equivalent to those on the surface of the sun which means you can't hold it too good in something, which means we use magnetic bottles. Magnetic bottles leak and they don't hold together too well. We have not yet achieved a temperature of x/dx times 10 to the something degrees for a duration of so long, and we have neither achieved the temperature nor the duration.

If we do though, what will happen? A couple of nice things. We have essentially an infinite fuel source to power the world for 2 million years at an exponential growth rate. An exponential growth rate of energy by fusion would dilute the concentration of heavy hydrogen in the sea by 1%. There is enough in there at an exponential growth rate to last until way after the sun burns out. All we have to do is make the thing work. Suppose it doesn't work? We are in trouble. The nice thing about fusion is that since it operates at such high temperatures, the efficiency is based on the upper temperature and the lower temperature and the ratio between them. The lower temperature is atmospheric. The upper temperature is huge. The efficiency of the thermodynamic cycle to produce electricity from fusion will be over 90 percent as opposed to 30 percent of existing heat sources. That means that instead of throwing away 70 percent as heat, you are only throwing away ten percent.

A UTILITY'S ROLE IN ENERGY CONSERVATION

Ralph Marrone, Manager of Technical Research
Energy Consulting Services, Northeast Utilities System

After looking over the program for this Conference, it is obvious that everyone here is well acquainted with the critical nature of the energy picture in the United States today.

There is an obvious mismatch between the supply and demand for energy and the prospects for a short-term solution are not too bright. Only through a concerted and effective energy conservation program will we reduce the growth rate of energy consumption sufficiently to assure an adequate supply for our essential needs during the next few years.

Most people seem to think first of electricity when a discussion of the energy dilemma arises, even though 75% of the Nation's energy use, and the greatest potential for energy savings is represented by fossil fuels. This high visibility of the electricity utilities requires a high degree of responsibility in meeting the needs of the public, and I welcome the opportunity to share with you, one electric utility's role in energy conservation.

Before I proceed further, let me give you some background about the Northeast Utilities System. It is composed of three major operating companies: The Connecticut Light and Power Company; The Hartford Electric Light Company; and the Western Massachusetts Electric Company, a wholesale power company; Holyoke Water Power Company; and a Service Company which provides the financing, purchasing, engineering and other services common to the operating companies. Our winter peak demand is in excess of the previous summer's peak, and our long-range projections indicate that this will continue to be the case for at least the next ten years. In addition, we have a forecasted growth in electric consumption of approximately 7-1/2% per year over that period of time, along with a slightly improving system load factor - all without any sales efforts on our part. About 30% of our kilowatthours (Kwh) come from nuclear units today, and this is expected to reach 65% by 1982.

We serve approximately a million customers in a varied territory, comprising much of the State of Connecticut and Western Massachusetts. We have a great deal of rural and suburban areas and several medium-size cities, including Hartford and Springfield.

About 43% of our revenue is from residential customers - thirty (30) from commercial and twenty (20) from industrial customers. Our average rate per Kwh for residential customers during 1973 was 3.06¢ (cents). We are also a Gas-Utility with about 10% of our total revenue coming from gas customers.

During the past fifteen years, a major transition has taken place in our Company. In the 50's and 60's, we sought an additional electric load which brought with it, the economies of scale associated with new and larger generating plants resulting in declining rates and a seemingly ever-abundant electric supply. In the late 60's and early 70's, however, escalating costs, environmental pressures, delays in construction and shortages of fuel combined to give early warnings of the end of a limitless energy era. After evaluating these changes, Northeast Utilities concluded that for the foreseeable future, it could look for little relief from rising costs, and could expect a general shortage of fossil fuels. We further anticipate that there will be substantial amounts of electricity substituted for other fuels, as customers try to meet environmental restrictions and hedge against the scarcity of natural gas and oil. It was apparent that the continued promotion of our product was incompatible with present realities, and a change in our whole marketing posture was needed if we were to respond properly to the national concern for energy supply. This led to a probing reappraisal of the System's marketing policy which, in turn, led to the evolution of entirely new objectives for our Company.

We decided that there would be no further promotion of our product, no load building activities of any form; but that we would instead, take an active role and, in fact, initiate assistance in energy management techniques with all of our customers. I stress the word "initiate" because Northeast management felt that to merely observe, or give lip-service, to the energy conservation needs of our customers would not be consistent with the type of service that we have rendered for years in the past.

In a sense, this role of energy management consultant is not a completely new one for our Company, since we have always offered suggestions on efficient electric use especially to our industrial customers. But energy conservation is new for most of our commercial and residential customers, and is now being developed to an even greater degree with all of our industries under this new program.

We have undergone a complete reorganization of our marketing department to meet these objectives. Last September, an Energy Consulting Services Department was formed to replace our sales organization. The employees were evaluated for their abilities to provide the quality of technical service that we feel is essential to our customers, and we have re-assigned those who did not meet our standards. We are also providing additional comprehensive training for those who have the basic skills that we require. In addition, the new department has been structured so that we now assign responsibility for customers on the basis of size, rather than end-use of our product, since many energy management techniques are common to customers of the same size, regardless of the type of business that they are in.

The organization of our new department has been completed and we are becoming more experienced and effective in the initiation of new energy management techniques with our customers. We do have an objective that we are working to meet for the 70's and beyond. We are committed to bring to our customers, energy management ideas that will cut their waste of all types of energy and, incidentally, save them money in the process.

It is against this background that I will outline what Northeast Utilities has done, is doing, and will do, in the area of energy conservation.

Our objective in September was the conservation of all forms of energy through wise and efficient use; this we call Energy Management. But the following month, the Arab Oil Embargo became a reality and we started our short-term measures to conserve energy.

We developed and supplied to our customers booklets on the wise and efficient use of energy. We produced a series of Guidelines and check lists for various types of customers, including residential, educational facilities, retail stores, office buildings and industrial plants. With the Guidelines and check lists, customers were able to institute their own Energy Conservation Programs.

We contacted all commercial and industrial customers and asked that they reduce this consumption of energy by 10% - 15%. We offered our customers our technical assistance and advice in determining the manner in which the reducttions could be made. We extended our program of conservation advertising directed to residential customers.

We passed out 100,000 copies of our Energy Conservation Booklet, including several thousand in Spanish, and we made available materials supplied by the State and Federal Governments. All Municipal Officials were provided with conservation materials and we assisted, where necessary, in setting up energy conservation programs for local governments.

Working with the appropriate people, we helped institute energy management committees and programs with our larger customers. We assisted the state government in the preparation of material for all citizens, instituted a 5% voltage reduction throughout New England, and started an in-house energy management program which remains in existence, and which I will discuss later. With bumper stickers, pins and other handouts, we tried to develop an energy conservation ethic among our customers.

These were short-term measures to conserve energy and they were very successful. Instead of the 7.5% increase in Kwh sales which is traditional in our area, and which we had forecasted, we began the year with a decrease of about 5.5%, and for the first six months of 1974, the energy use by Northeast Utilities' customers was almost 4% lower than the corresponding period of one year ago. Therefore, we can conclude that our conservation efforts, together with Governmental action and a warmer winter, have resulted in a decrease of approximately 12% below the projections. This is an annual equivalent of more than 4 MILLION BARRELS OF OIL.

It should also be pointed out at this time, that the reduced use of energy does have its consequences on a supplying utility, and has contributed to a sharp decrease in earnings for our stockholders, and to the general financial difficulties of our company.

In our own Company, Northeast Utilities, we initiated an energy management program which has been successful, and which will continue into the future. To describe the program, I'll read from the Letter of Instruction by Northeast President and Chairman, Lelan F. Sillin, Jr., to all System Officers:

> "At a time when the Nation faces a mounting shortage of fuels and energy, we have an obligation to provide leadership in the conservation and efficient use of energy in the facilities of the Northeast Utilities System. This makes not only good economic sense, but enhances our ability to prescribe measures that our customers can take in concert with the nationwide effort to reduce fuels and energy consumption. This Energy Management Program will be a major system priority. All employees should become acquainted with the plan, and will be expected to cooperate to the fullest in its implementation.
>
> "The basic program is as follows:
>
> (1) Energy Management Committees will be established in every office, service building and production plant. It will be the duty of these committees to seek out, evaluate and recommend to the person in authority at each district, division or area office, service building, production plant and general office building (hereafter referred to as Manager), energy utilization practices which will meet the corporate goal of a 10% reduction in energy use.
>
> " The Manager will be responsible for the successful execution of the program and for meeting the system's energy reduction goal. He will appoint the Energy Management Committee and assign the responsibility to it for preparing energy utilization recommendations and monitoring results. Although the committee size can vary, depending upon the size of the facility, it should consist of at least three people, but no more than five, so as not to become unwieldy. The

majority of its members should be experienced in the use of energy and knowledgeable enough to recognize possibilities for efficient energy management. Members of the Energy Consulting Services Department will be available for consultation by the committee and will provide assistance as requested.

"   The committee will have a chairman who will have direct access to the Manager of the facility. The Manager will hold a meeting with the committee at its inception to explain the purpose of the Energy Management Program, the scope of the committee's duties, and the results that are expected. Concurrently, he will explain to all other employees in the facility, what the committee's function will be and enlist their support in suggesting ways to reduce energy waste.

"   The scope of the committee's activities will be to (1) look for ways to improve energy-use efficiency and reduce waste; (2) evaluate the cost-benefits involved; (3) recommend methods of energy utilization improvement to the Manager of the facility; (4) monitor the implementation of improvements; (5) evaluate results; and (6) report the progress, with recommendations, to the Manager.

"   The committee will meet regularly, survey all areas of energy use in the facility and solicit suggestions from other employees to evaluate along with their own. Each recommendation prepared by the committee for energy utilization improvement should include the estimated annual energy savings, the cost of any modifications to the system necessary to obtain these savings, and a recommended course of action.

"   To be effective, the committee will be given the time from their regularly assigned duties needed to survey the facilities and make their recommendations. The time should be scheduled by the Manager and should be on a continuing basis.

"   The committee will develop methods of saving all fuels used at their facility - gas, propane, electricity, fuel oil and gasoline or diesel fuel. Energy savings which will result from their recommendation should be calculated, rather than measured, to eliminate variations caused by weather, expansion of facilities, or other changes beyond the control of employees. Calculations will be based upon simple formulae, developed by the Energy Consulting Services Department for uniformity.

"   These will produce a savings in energy units to obtain a percentage reduction in energy use and the resultant savings in dollars to the system.

"   The committee will also develop a scoreboard system of announcing the results of the Energy Management Program for their facility to all employees there. This scoreboard should be updated quarterly and should help to involve all employees in the program, as well as encourage their continued suggestions for improvements.

"(2) Over the 1973-74 winter period beginning December 1, monthly reports will be made by the Manager of each office to the Company Presidents for their review and dissemination to appropriate NU personnel. In the Service Company, reports will be made to the Executive Vice President-Service Groups. These will detail the energy savings accomplished, the methods of accomplishment and, where appropriate, the reasons why they are not obtaining energy savings at the rate of 10% annually.

"(3) Those system departments with the responsibility for design and construction of new facilities or the selection of new energy-using equipment will make an examination of their design criteria,

> as well as architects' and engineers' project designs, to ensure conformance with efficient energy-use objectives. Design parameters and equipment specifications will be tested to ensure that the maximum cost/benefit/energy efficiency ratio is obtained. The Energy Consulting Services Department staff will review all plans for new facilities to assist in meeting these objectives.
>
> "(4) A recognition system, involving the Managers, Company Presidents and NUSCO Executive Vice President-Service Groups, will be established to reward those Energy Management Committees that produce the best results. This recognition will be publicized to all employees. The Company Presidents also will determine, from those responsible, why they are not meeting their energy savings obligations. They will be made aware of the importance of this effort and given guidance toward areas of energy utilization improvement that may have been overlooked."

To implement the program, we designed a reporting form which is sent in each month from all of our properties and a set of Guidelines for our people to use. The energy saving goal was increased to 15% and except in the area of gasoline, we have exceeded the goal each month. Between November 1973 and May 1974, we have reduced energy usage by 16.4% or 59,806,000,000 BTU's without gasoline and 10% or 58,006,000,000 BTU's including gasoline. We had a severe ice storm in Connecticut during December 1973, which increased our gasoline consumption tremendously, or our results would have been even better. This saving in energy equals almost $400,000 so it is obvious that energy conservation makes good sense economically also.

Our Energy Management Program illustrates several points which are necessary if an energy conservation program is to be successful.

(1) The program must have Top Management Support;
(2) A committee or individual must be responsible for obtaining the energy savings;
(3) The committees must be given a goal or sense of direction;
(4) Check-off lists of potential sources of energy waste should be made available;
(5) Cooperation of all employees is necessary; and
(6) Recognition of efforts and results will help to foster continued interest in the Program.

Looking to the future, we will continue our efforts to convince our customers that there is a continuing need to use energy wisely. Since the end of the oil embargo, the interest in conservation has decreased and we must remind the public that the energy shortage will be with us for a considerable length of time.

Our long-term plans call for continued assistance in setting up energy management programs with our larger customers and providing information to our smaller commercial and residential customers.

Next, I will describe what our role, and what I feel the role of electric utilities in general, should be in the energy conservation effort.

With the smaller customer, who does not have the manpower or the expertise to form his own management committee; or is too small to retain a consulting engineer, a survey by the utility representative is most appropriate. In these cases, the utility should initiate and undertake the survey of the customer's home or place of business, make recommendations that may lead to changes in equipment or methods of operation to improve their energy efficiency and instill in the owner, an awareness of the need for good energy management.

With both the large and small customers, the utility representative fulfills an important role by asking questions. Regardless of the type of fuel involved, it is his function to ask the customer why a procedure can't be improved or a change made to reduce the energy consumption.

The utility should also provide estimates of projected electric costs which, along with the projected costs of other fuels, should be recognized in any cost/benefit study. With the outlook for escalating fuel prices and equipment costs over the next few years, any study should reflect these increases to give a true picture of the long-range consequences of an investment in equipment or systems. This study should assist the customer to choose the most energy efficient equipment consistent with the necessary economic considerations. The utility consultants should look for energy conservation opportunities on the customer's premises and use of heat always carries with it the potential for large savings. We should concentrate on possible ways to eliminate or capture waste heat and get better use from each BTU. Initial suggestions may range from temperature setbacks to the cleaning of filters on heating and cooling systems, to recommendations for improved boiler maintenance or burner adjustment. Since substantial savings are often available after the expenditure of funds to refit existing equipment, the utility representative should then look for those areas where better insulation for buildings, pipes or ducts will improve efficiency. The possibility of heat reclaim equipment is always investigated and each process should be observed with the idea of heat recovery uppermost in mind.

Another area of particular concern is in improving the load factor by reducing the electric demand of customers. To do this properly, the utility must be willing to install demand recording equipment. Data from this metering is used to prepare a demand curve of the customer's requirements, from which the feasibility of demand control equipment can be analyzed. By smoothing out the demand curve, the customer will make better utilization of his own electric distribution system and improve the load factor of the utility. We have a major metering program under way at this time with residential customers, both for rate purposes and for information concerning the improvement of system efficiency.

The effective utility representative should consider himself not only a specialist in the use of electricity, but also a generalist in the use of all forms of energy. He is, therefore, able to recognize a problem and then act as the catalyst to bring together his customer, or agent with the problem and an outside expert with the solution. Manufacturers of heat recovery units, insulating materials, and the wide range of energy conserving equipment and systems should be brought in when the need exists for their expertise. For example, we recently had a customer who was interested in relighting a large area of his building. Our representative talked to him about the energy efficiency of various light sources and then, with the customer's approval, asked a lighting equipment manufacturer to develop a study showing the most efficient light source for the customer's needs. This was done and the customer has now installed a system which provides his illumination requirements with equipment having the lowest energy use to meet these requirements.

With larger customers, we will suggest the use of a consultant if they have no in-house capability for either plant survey work or specific engineering studies. In these cases, we view our role as being supportative to the consultant and providing the answers to specific questions about the customer's use of our service - everything from the calculation of his bills to the construction of a load curve from our graphic demand data. In no case do we compete with a consultant - rather we assist him in his studies of the customer's use of our service wherever we can. At our Company, we believe that retaining a professional, especially by the larger customers, brings an expertise to bear on energy utilization problems that can often lead to unique and extremely profitable solutions for our customers.

A major role of the electric utility is that of an information source. Because of its position as the middleman between equipment manufacturers and endusers of its product, the utility has a fund of knowledge on energy and energy-using equipment that it should direct to its customers. For example, utilities can help their customers by the presentation of training or educational meetings. These meetings outline some of the methods that can be used to improve the energy efficiency of plants, businesses and homes. A number of available courses bear down heavily on the subject of proper energy utilization and are of the "how to do it" variety that are most helpful to our people. Further than that, however, a utility should develop, either itself or with others, additional programs on energy utilization that it feels would be helpful to all of its customers. At Northeast, we feel strongly enough about this subject of training to have a Staff Manager in our department whose major responsibility is to provide educational programs both for our own department's employees and for our customers.

We have provided each member of the Energy Consulting Services Department with a Technical Reference Data File, which contains information about the various areas of energy utilization including lighting, heating, cooling, water heating, heat recovery, power distribution and construction techniques.

The file is an on-going project which is continually being updated. It contains a section on codes and our people are familiar with OSHA, FHA Insulation Standards and others, which affect the consumption of energy. We must be able to provide this information, not only to our customers, but also to architects and engineers.

Before I leave this subject of education, I should also point out that there is one other area where we think the utility can be of help. That is in the publication of periodicals or reference brochures for distribution to customers. These are a way of up-dating the customers' reference files and improving their knowledge of the changes and new developments in equipment, energy conservation techniques and operating procedures. A simple example of this is the brochure that we sent to our industrial and large commercial customers as far back as October of 1972, which offered more information on energy conservation systems. Our offering was, in effect, a compilation of reprints describing various equipment and processes that would help these customers use our service more efficiently. This put reference material into the hands of our customers gleaned from sources that might not be readily available to them.

Today the Federal, State and Municipal Governments are studying and proposing legislation aimed at reducing energy consumption and some have already done so. In Connecticut, the State Building Code is currently being examined and revisions drawn up which may legislate construction standards to improve the efficiency of energy utilization in new buildings. We have been active in assisting with the proposed changes and have provided information on lighting, insulation, fenestration and ventilation to the group developing the proposed standards.

We, and I'm sure many others, stand ready to help our customers or their consultants with computerized energy-use studies for new buildings.

These studies should be based upon design criteria that offer the most efficient use of the fuels being studied. For example, for new construction, we base our energy studies on full insulation and double glazing, regardless of the the type of fuel used, and encourage the customer to factor optimum energy use by considering the affects of orientation and configuration, into the design of these facilities, no matter what fuel is selected to heat or cool them. This leads to another technical information service which should become a larger part of the utility's responsibility to its customers. That is the analyzing of equipment, and publishing of data, that will guide its customers in their selection of new equipment to meet the highest efficiency standards. I'm sure most of you are aware of the energy efficiency ratios which have been developed for window air conditioning units. These, the lumens per watt ratings of various light sources and similar energy use data on other types of equipment, should be compiled by the utilities into a ready reference form to guide both them, and their customers, in the selection of future capital additions. We have done this.

We see the electric utility in the role of an innovator with its customers. By this, I mean that the utility must be willing to thoroughly investigate new ideas and, if they have merit, adopt those that work to the mutual advantage of the utility and their customers. One that immediately comes to mind, and where some utilities have taken a leadership role, is in the ownership of on-site generating systems. The customer captures the waste heat for process or other purposes, and the overall energy efficiency of providing that customer's total energy requirements is drastically increased. This is but one of many examples. Modular integrated utility systems being promoted by HUD is another. The main point is that we must keep an open mind and be receptive to new ideas that will meet our mutual objective of energy conservation.

At Northeast we are attempting to evaluate all of the methods which can lead to the most efficient utilization of our product, from heat pumps to load shaping, from radio controlled water heaters and other equipment, to new rate structures and solar energy.

We are a member of the Electric Power Research Institute, the research arm of the utility industry and contribute to its operating budget which is expected to be $90 million in 1975.

Our research efforts are dedicated to developing the techniques which will ultimately lead to energy self-sufficiency for the country and to the particular devices and systems that are the most compatible with a sound environment and economy. Some 15 projects are concerned with nuclear technology, others with coal gasification, flue gas scrubbers, fuel cells and high-energy storage batteries.

We will continue to urge each of our customers to set up and maintain personal energy management programs. The main objective will be to eliminate wastes of, not only electricity, but all types of energy. I have outlined the many ways which we can assist in this endeavor, but final results will depend upon how well we can convince the public that the energy crisis is real and that it can be solved only with everyone's cooperation.

QUESTION AND ANSWER SESSION

"A Utility's Role In Energy Conservation"

Speaker: Ralph Marrone

DELEGATE: Your accomplishments in reducing energy demand are very commendable, but there is one area in which there seems to be a problem. This area is rate structures. Why are large consumers of electricity charged less than small consumers?

MARRONE: That is a question which is in the forefront as everyone's asking it. There has been a larger increase in the rates of industrial and larger commercial customers than in the residential; they have been coming together.

We have a fuel adjustment clause, which is a dirty word with many people in our area, but what this simply means is that there is an adjustment based on the price of oil which has gone from $1.90 to $14.00 a barrel. It is based on kilowatt hours, and it affects all customers the same for each kilowatt hour that they use. So, percentage-wise, the increase to the industrial customers, the largest user, is much higher than the residential customer.

There are many consequences, however, to increasing the rates of the industrial customers and the effect on the economy and peoples' jobs must be considered.

DELEGATE: I'm interested in your water-cooling system. I saw in one of the pictures that you had a river that you used to cool off the--was that a fossil fuel plant?

MARRONE: Yes. That was a fossil fuel plant.

DELEGATE: What water temperature changes have been due to nuclear power plants?

MARRONE: As I said earlier, I'm not going to duck any of your questions. When we started planning for nuclear plants on rivers, we charged research groups to study water temperatures and other affects of the plants. I don't know exactly what the increase in temperature has been--I would say ten-to-twenty degrees.

DELEGATE: These research groups, what were their findings?

MARRONE: There has been very little impact on the Connecticut River, for example, of significance. I could send you a copy of the research and the results. The research has been going on for a number of years, and it is particularly gratifying to us that we did start it years before the plants were built so we do have the information which indicates the state of the river before it was disturbed and the condition at the present time. These are not assumptions as the evaluation has been done by independent people who don't care whether they tell us what we want to hear or not.

DELEGATE: Have you had fish killed due to an increase in water temperature?

MARRONE: We have had some fish killed, most of them by being sucked into the intake screens of the cooling water systems. These have been redesigned. Yes, we have had some fish killed, but very few due to the increase in water temptérature. There have been some changes in the ecology of the river, certain species of fish have been affected, but there have no dire consequences.

DELEGATE: Who were the studies done on the Connecticut River funded by?

MARRONE: We have had people from Yale doing some of them. Some have been funded by us, but other groups have been doing a good deal on their own. I realize that there is some significance to us paying for a study. However, we have paid for studies by independent groups and the results indicated that a project was not welcome in a particular area. There is a risk to funding research when you don't know what the answer will be, but we have done this.

DELEGATE: I live in Massachusetts now and last winter we had freaky weather in the sense that our temperature in the middle of January was up to 60 degrees. I would like to know if we will have enough electricity next year to survive a normal winter?

MARRONE: Yes, we do but I shouldn't say that unequivocally as each Company does not serve its customers independently. As you probably know, living in New England, all of the electric production and distribution is tied together through a system called NEPOOL. The New England Power Pool takes the output of all the companies and puts it all together and dispatches it to any Company which requires it. The reserves of the Companies which serve Connecticut and Massachusetts are large enough to take care of our area, unless we have a major shutdown. We had a voltage reduction this summer for other reasons and this could happen again.

DELEGATE: Speaking of voltage reductions, this past summer power to my house was cut off about three times. There was a blackout in my area, a couple times over. It's very inconvenient not being able to go up and do your homework because there are no lights.

MARRONE: Well, it wasn't done because we didn't have the power; it was done for some other reason. We have had no blackouts or brownouts this summer because we couldn't serve customers. We've had blackouts for other reasons: someone hitting a pole for a main transmission line or failure of some equipment.

DELEGATE: One of your points was that education is needed in order to conserve energy. At my school, which is M.I.T., during the winter we had all these energy saving things like shutting off the lights in the locker room (so you can't see how to open your lock) and stuff like that, and they were reducing the heat, but now, while they're having research projects done at my school on energy conservation, our energy consumption is back to normal. We haven't been reducing energy here or there. Did you know air-conditioning is still full blast in various buildings?

MARRONE: That may be true on an individual basis, but it is not true generally. Electric consumption is down, at least in the territory we serve and in some cases more than it was this winter. Electric consumption is down about 7% for the last couple of months, 14% in one of our companies, but 7% on the average. So, our customers are not using as much power for some reason. We think our efforts are partly responsible.

I think M.I.T. or any place else should continue its energy management program. At Connecticut College, they had a very extensive Energy Management Program. In fact, they shut down the school for several weeks which didn't make some people happy, but nevertheless, they came up with some real results. They went through the campus with a fine-tooth comb and did all of the things we had prescribed for them to do. The unfortunate thing was that with fuel prices going up, the money savings they expected were not there, eventhough they have reduced their power consumption.

Yes, some people are attempting to hold down their use by continuing Energy Management Programs.

PANEL DISCUSSION
"ENERGY CONSERVATION"

Panel Members: George Reeves, Manager, Long-Range Planning,
Electric Energy Association; and
Dr. Douglas C. Bauer, Director of Research Planning and
Systems Studies, Conservation and Environment,
Federal Energy Administration

DELEGATE: My question is to Dr. Bauer. You were talking before about all the different things the Federal Energy Administration (FEA) is doing and what they are hoping for and really it all seems to get back to the idea that you need the people's cooperation in this country. What kind of things can FEA do to stimulate people's interest in energy and to get people to cut back on energy? What are they doing now and what can they do?

BAUER: In terms of enforcement, I used that in a very restricted sense. That is: what regulatory authority is vested in the FEA? I've indicated that they are limited. They are in the allocation. In terms of persuasive authority and in terms of executive orders, there are numbers of things that they can and have done. For example, lighting standards is a question that has come up in regards to the kind of lighting levels that we have for different tasks. We have implemented mandatory standards in federal facilities that are very important, and we have also established voluntary standards for implementation in the country. To get something to happen, you find very quickly you either have to go through executive orders for which the jurisdiction is carefully constrained or you have to go into new legislation which is a very difficult process in itself to, in fact, cause to happen.

We have a very large public information awareness activity to try to get to local authorities either through regional offices, through the state governors' offices, or the mayors directly. Information is given of what can happen if they undertake, in their state jurisdictions, certain kinds of standards and certain kinds of actions. In answer to your question about what FEA can do to cause it to happen, I think it has to be taken for granted that it must operate through other institutions to cause things to happen; either through the Congress in terms of standards, through some executive orders for which the limit of that authority is on federal facilities, not trivial but considerable, or through causing it to happen in the states directly and in the cities directly.

DELEGATE: The reason I asked the question is that Frank Murray here from the Center for Strategic and International Studies, Georgetown University, yesterday was telling us we lost our golden opportunity last spring with the energy crisis. The energy consumption went down at that time but now it's gone back up and we're going to the point where the voluntary things by people and FEA's persuasion is really not effective at all. It seems to me that we have to use something else besides the fear tactic or persuasion. We have to use something else besides that if we're going to cut down on energy consumption, and I understand that's the heart of the whole program of FEA: they've got to find something else to do. I'm wondering what else they're going to do if there is anything...

BAUER: I think we can save a major amount of energy in this country by simply pointing out to the people who are using the energy the ways in which they can use less. Not by reducing; not by being afraid and shutting off the lights; not by reducing the benefits from that energy, but by using energy more efficiently to get the same benefits using less energy. For example, take automobiles, using a more efficient automobile engine; for heating, using a heat pump instead of burning it. I think the FEA has a job in identifying and communicating to the public, the various policies involved, the opportunities to save energy, and at the prices that energy is going to be at next year. It's going to be a very, very strong motivator to do something about this difficulty. We can save real bucks in terms of energy.

DELEGATE: Prices are up now, and people are still using as much energy as they were before the energy problem or whatever it was.

BAUER: Not true, not true at all. Electrical growth has come way down. The growth rate in residential areas was going up like eight percent per year, historically forever, and as of last month the year to date numbers are negative for a great many electric companies.

DELEGATE: The gasoline price in some places has doubled.

BAUER: Gasoline consumption has, in fact, decreased. It's the same question. The questions you run into are really what are the options? The same is true in the electrical field. For example, obviously, their concern is with the peak requirements: you'd like to get more people to use more electricity at night. What are the present options that they have to use more electricity at night? How many homes have storage devices that can effectively cause the off-peak power to be used and stored and then use that in turn for heating homes during the day or for lights or whatever?

The point here is that there are not that many options in the near term. You're talking about a whole system that's been built in the country, a whole technology that's existing in the country, and you're not going to change overnight. You're going to change it in time. In the language of economists, it's wrapped up in so-called elasticity. That is, for a certain amount of increase in price, what is the change in the demand for that commodity?

The real problem is the time period over which you're going to be able to see some changes. You're not going to see them overnight. You think of things you want to do now to reduce energy, but we have done a lot of things. Maybe some of you think some of them have been heavy-handed. We were very much involved in what I call curtailments. Now 55 miles an hour speed limit is a curtailment. Maybe you would like to go 70, but we did that. That's one thing that you can get done. Daylight Saving Time--how many of you like Daylight Saving Time? How many parents like their kids getting up in the dark and going to school in the morning?

It turns out that are things you can do promptly but if you think of electricity usage in the home, as a part of electricity usage for example, what kinds of things can you really do in your home after you've tried to keep the lights off and you've gone through all these kinds of things? What opportunities do you really have to manage the amount of energy that you use each day? Not as many as you do over a longer period of time when you can think about different systems that can be put in the home. It's very important that we keep in mind the time period over which we're going to accomplish permanent kinds of conservation actions in the country. It's not going to be tomorrow. It's a long-term problem to provide more options for people to be able to use energy more efficiently.

DELEGATE: What you're trying to say then is basically that people won't do it themselves as quickly as if there were some force--some other incentive besides just...

BAUER: How do you want people to do it? I think that's a very key thing, which goes back to the private market question that's been raised before. You could have talked about conservation as a scientist as a number did twenty years ago. We've known we're going to be running into an energy problem about the 1970's. What did that mean to a homeowner? Not a heck of a lot, because it wasn't a problem crunching upon him. So, he didn't demand in the market place those products that have more efficiency because it wasn't a big deal as far as he was concerned. It's obviously a big deal with everyone here, and with other people in the economy. That means that now when they go to the market place and buy an air-conditioner, the fact that there is a label on it, that the feds have caused to be put on it, that states in the energy efficiency ratio as to how much cooling you get for how much electrical energy that's in it. That's important to you, and therefore eventually you will make that a more valuable and more important criteria in which one you buy. That is, the consumer will start to demand in the market place, and therefore it will tend to produce products that will meet that demand. The entire life-cycle cost of that product, not just the initial purchase price, will become important.

So maybe you're willing to buy an air-conditioner that costs more money to you because you recognize that over the lifetime of that conditioner it's going to end up by netting you more amenity, cooling, for less total dollar output as far as you're concerned. But if you ask the feds, if you beg the feds right now on the front end to mandate certain kinds of activities, I think what you're going to be doing is you're going to introduce all kinds of distortions that don't represent what it is in the long-term, the ten year time frame, the kind of thing that makes sense to consumers and to our free market, our economic system in the country.

The attitude of the government has been: Look, prices are going up. In one sense, that's a hassle too. How many of us like inflation? Our claim is that the relative increase of energy prices is good not bad. It's been undervalued as a commodity and the fact that energy prices are going up sends signals into the economy that cause people to be more discriminating in the choices they make on what they buy. I don't think you set up a set of regulations to mandate that.

DELEGATE: Your basic attitude, then, at the FEA is let's leave things alone, just tell people by persuasion what they can do and let the market take care of it.

BAUER: Parts of that are correct and parts of it are wrong. We're not leaving things alone. There are a series of regulations that have been put into effect; voluntary standards where we can and mandatory standards: lighting is one. We have had others. The transportation speed limit is kind of an issue. With industry we're setting formal targets, and we're setting targets for automobile manufacturers so we're not leaving things alone, but as far as the second part of what you said, that is a very sharp reliance upon the price mechanism, you bet. Very important as far as the other issue is how do you get rid of a lot of the other screwups that are in the system right now that don't allow that price mechanism to work? Get rid of the past interventions of the feds into the market system that have caused a lot of the grief that we're living through today?

DELEGATE: To Mr. Reeves. Like brown-outs and black-outs. (I'm an economist, O.K.?) They all have a variety of causes and some of them have a lot to do with interruption of production, accidents, inconveniences, etc. What I'm curious about is you're talking about your peak-load requirements and about how you have high capital costs and all this sort of stuff. Have you really considered trying to push all your regulatory commissions to allow you to do peak-load pricing?

REEVES: Unfortunately, the way the rate theory grew up, peak-load pricing is nowhere near as nice as it should be; but there are now approximately twenty percent of the industry switched to a dual summer-winter rate so that the price in the summer is more expensive. Ideally, you would pay a fairly substantial charge for your usage of electricity at the time of peak, and a flat rate for the rest of the year; but there are local peaks and regional peaks and peaks on the wire that runs down the block, etc. Yes, we are doing a great deal of peak-pricing.

DELEGATE: My second question to you is: from around 1823 to 1866 most of the U.S. and the world were relying on their lighting requirements on sperm oil and just plain whale oil. Now, what I'm getting to is that I'm curious about the fact that they knew that they had a finite resource right then. They knew if they killed too many whales that was it. Now, they allowed a market system to ration it, and they had no program long-range planning things, and miraculously they didn't have any shortages under the normal situation, but there was a price thing. From 1823, the price went up from 43 cents a gallon to about $2.55 a gallon in 1866. That's a pretty massive increase in prices. What I'm getting at, though, is that here they didn't have this problem with resource allocation, other products came to be used later on, they had mass discovery of oil in Pennsylvania later, and it turned out the price of whale oil went down about 40 cents a gallon.

What I'm curious about is, through all the prognostications that I've been seeing here, everybody's been assuming that there's not going to be any relative changes in any energy commodity. What's going to happen? I'm curious about all your planning mechanisms now. I haven't seen anything. All these predictions are always assuming, apparently anyway, that we have constant costs; and I don't quite see that from the examples of model buildings I've seen, I'm curious about what your attitude is now toward market system allocations, prices, and relative costs?

REEVES: One has to argue in trying to forecast the future with alternative prices on commodities that we don't know what they will be, in fact. Oil could be anywhere from probably a lower limit of 7 dollars a barrel upwards anywhere to 12 dollars a barrel and different things happen to the economy depending on what that price is. In terms of the context of Project Independence, which is really the blueprint by which we examine all those futures to try to draw some conclusions as to what kind of future we want, we're considering futures based upon $4.00 per barrel scenario, if you like, 7 dollars scenario, and 11 dollars per barrel scenarios. If this is the price of oil, then what kind of future do we want to have? How much resource development? Of what kinds do we want to promote and how much conservation seems to make sense...and it's economic at those prices of oil.

I think that's part of the answer to your question, but I don't think it hits at it directly in terms of the economic planning; we don't in this country have centralized economic planning. It's not a centrally directed economy as it would be in a socialistic system.

The example you raised back in the 1800's is one in which the rising price of the commodity which is at issue here, the oil for lighting, caused things to happen. In other words, it's not de-coupled from the fact that that price went up, that you did find other ways to provide that amenity. Our feeling is that probably that's the best way to do it rather than to pre-ordain or forbid, for example, the use of sperm oil because the whales are going down in population. You don't do that. You let the market itself drive it. I'd like to point out the impact of technology in that example, too. In 1879, the electric light was made practical by Thomas Edison in West Orange, New Jersey.

DELEGATE: Some elasticities of demands as far as gasoline--it's said there was a one percent increase in prices so you'd expect to see a one percent increase in the supply of gasoline. I was wondering if you have any comments about that at all, if those have been changed?

REEVES: Yes. Our knowledge of elasticity is something you should take with an unbelievable degree of caution. At best, they are a reflection of an assessment of what happened in the past which is a very vague indicator, perhaps a misleading one, of what might happen in the future; and secondly, specifically with respect to gasoline. In regards to the estimates that we are operating under now, you're using elasticity in a different sense than I am. I'm talking about how demand is affected while you were talking about how supplies might come into being, that's a different concept; we're talking about demand. If you look at the future those estimates specifically with gasoline are all over the place. They're off by factors of three in terms of how much reduction in demand will occur as a consequence of the price increase.

The second problem in that, that is even if you knew what that number was, and it was in fact truthful, that is incredibly prophetic, and you were able to understand the future, not the past, you've got a problem over what time period does that elasticity take hold? Does it take hold promptly? Again, it comes to this question: How much discretion do you really have over your near-term usage if you're living in a house in suburbia and there's no bus and no mass-transit system? You've got to work, so tomorrow you'll take your car, whether gasoline is 80 cents a gallon or it's 40 cents because you really don't have discretion. But over the long-term you might move elsewhere or they might then build a bus route. You have to ask yourself the question concerning the effect upon demand of increases in prices: How long have you got to wait for that structure before you'll get some kind of response?

DELEGATE: I'd like to discuss the costs of the kinds of things you're mentioning, such as the reduced speed limits on the freeways. This is going to sound gruesome, but in terms of economics, it's a reality. You're talking about reduced speed limits saving energy and also saving lives, but if you save ten thousand lives a year, that's ten thousand lives that are burning up energy that wouldn't have been burned up otherwise. The point is in a real system these are the kinds of things you have to consider. Everything is interrelated, and when you make a savings you better make damn sure it isn't causing a loss somewhere else in your system.

DELEGATE: You're not taking into account time taken out for funerals, loss of work...

DELEGATE: I was just attempting to make a point in terms of integration of what you're looking at rather than a separation of it. You've been talking about the FEA in terms of a persuasive role by using free market mechanisms, yet in reality, the things you have mentioned have been price controls, using other agencies to put in subsidies. You mentioned railroads in particular with this kind of thing. The question I'd like to ask you is first a philosophical one: Who do you think ought to make the decisions? When you say we make the decisions in terms of the FEA making decisions, the government making decisions, you mean the government and the people, but in point of fact, of course, we become those people on the policy boards. So, the question is, number one: Who do you think as a member of the FEA ought to make decisions--the government or the individuals by their economic controls?

I'll ask the second question at the same time--you can pick it up. Assuming you want the control through the government, you have to have information. You have to arrive at a decision by applying criteria and then you get a result. Do you have a high enough information ratio? Well, you said you didn't, you said all your things are guesses; but, can you achieve a high enough information ratio in relation to the information that is available to reach a meaningful decision? Those are the two questions.

BAUER: I'm sorry, but in the language of a physicist, those aren't well-posed questions. You've got to talk about which decision and then you have to talk about which information from which decision. If you're talking broadly in the field of energy, as to whom should conceive of the national energy policy that involves so many elements in our society, then it must be a political decision. That is, it must be a decision that is made as a consequence of what our country accepts in its respective governmental forums at local, state, and federal levels. How much environmental degredation? How much resource independence from foreign countries? How much amenity, that is, life-style?

There is just no way that you can get a federal institution, and I hope we never get to that point that would say "pre-ordain" all those kinds of choices. No way can it be done. In terms of information or decisions that we have to make you always want more information than you've got. But, you have to talk about which decision and which piece of information supporting that decision you're talking about. If you want to raise a few examples, I'd be happy to say, "Yes, feds, no feds, or state people individually, or whatever."

I would not subscribe to the thesis finally that the federal government ought to be the one that ordains or controls the entire energy problem. I'm delighted that its leverages are as few as they are, and I think it would be exceedingly damaging if the leverages became more. I would think our whole experience of regulated industries, as such, shows that in regards to the price we pay into the electric utilities to become a national industry, I agree wholeheartedly with George, that the track they might follow is precisely the railroad track and that's a mess. I don't think we want that.

FRADIN (FASST National Office): One of the thoughts that we came up with when we first formed FASST and my father being a plumber fighting building codes all the time, the number of times I worked as an apprentice in the summer, you could pay off the building inspector for 5 dollars a unit; he never enforced plumbing codes, and I'm glad to see this kind of thing coming out. I wanted to ask George and even Doug: What could we do in terms of students at the grassroots level by taking this thing and making sure it's enforced or whatever?

REEVES: The procedure that will be followed with this document is that regardless of what the national council of states on building codes and standards does with it, the American Society of Heating, Refrigeration and Airconditioning Engineers (ASHRAE) is going to issue an ASHRAE standard which is voluntary. This will probably be done in late October. The document is now out for a 90-day public review. Anybody can comment on it; I gave Dave the only copy I have. I believe the address of the organization is listed there, and he can get details; you can write if you want copies. After the comments are all put together, and every comment will be answered, then ASHRAE will most probably issue this as a standard, and probably sponsor this as an American National Standard which has a very high formality to it. There is a very rigid procedure in order to do that. If that exists, it will become a national voluntary consensus standard.

Through the other route, the national conference, state and building codes and standards (if they adopt it) will send it to the state building code people in every state, and the third route that's being followed in individual states--I can think of Illinois, New York, Oregon, Texas, New Jersey real quick--are already sponsoring energy conservation building codes and waiting with baited breath for this thing. If your state is not one of those, you can exert influence at the local and state level. There can be local building codes as well as statewide codes. If your state is running off in one direction with an "energy conservation building code," you can influence it back in another direction because this is developed by the guys who know what they're talking about.

FRADIN: One thing we could do right now is to form an Ad Hoc Committee of a group of representatives from this conference to study each of the home building and other codes, in other words this manual. We could take a look at the thing on a nationwide basis and develop some sort of a manual that we could use as students to encourage state, local and federal agencies which set building codes to upgrade their installation standards or take other measures in order to conserve energy. We could take this little manual and put it in the hands of any group of students on campus who could go out and work on a local level to see that these kinds of things are enforced or implemented.

DELEGATE: That would be a very hard thing to do. I've dealt with some of the tenant associations at Purdue, and we ran into a lot of very difficult problems. When you start to enforce building codes, all you end up doing is eliminating all the low cost housing, which means you are eliminating housing for students who cannot afford to live in good buildings. I talked to a city engineer about this. By enforcing building codes, I'm eliminating an opportunity for students to go to school. That's really the fact, and it's a very complex issue: How do you get good low-cost student housing?

REEVES: In the design of this document, practically all the procedures recommended, such as this much insulation for this kind of building, are designed to be cost benefit effective such that the additional cost of the insulation will be economical in terms of the energy saving. So it should not change, or it should lower the rent on the housing in the long run, for example.

DELEGATE: It should. I don't know what the situation is in student housing in other areas--all I know is many districts, which are the old homes, the landlords just want to suck as much rent out of them as they can before they're going to be torn down. They're not going to do anything to them to improve them at all. Slum lords want to get as much as they can while they can. In Purdue, there is a shortage of housing. I estimate at our university like 8 to 10 thousand people who want to get into university housing that won't be able to, so the slum lords know that and increase prices and do absolutely no improvement--it's a complicated social problem.

Towards a National Energy Policy

THE ECONOMICS OF ENERGY

Jack L. Schenck, Assistant Director, Economics and Statistics
Edison Electric Institute

SOME THOUGHTS ON THE ECONOMICS OF ENERGY

I. Introduction.

To cover a topic as broad as the economics of energy in a mere 30 or 40 minutes is an impossible task, and recognizing this, I shall limit my observations to certain aspects of energy economics which I believe to be essential to an understanding of our nation's energy problems.

The increasing per capita use of energy has, since the beginning of history, been associated with the improvement of man's economic, intellectual, and moral state. The discovery of fire, domestication of work animals, harnessing of wind and water, and finally the practical application of steam power marked the major breakthroughs of man's energy efforts until 100 years ago. Since then, we have continued to improve the inanimate sources. We can raise steam by splitting the atom. We've turned the water wheel into an electric power producer, and developed the internal combustion engine as a mobile power source.

All of these advances have meant greater productivity of labor, which in turn has meant more wealth or surplus, which in turn has permitted man more time for reflection on the human condition. That this process has been more or less continuous since man's beginning is intuitively obvious. However, over the last several decades it has also been measurable thanks to the development of national income accounts and national energy balance sheets.

II. The Need for Increasing Energy Consumption.

Energy/GNP ratios.

Perhaps the most important measure of the relationship between energy use and economic well being is the so-called energy/GNP ratio, Btu's per real dollar of GNP. Starting in the 1920's this ratio began a long term secular decline in the U.S., implying an improving efficiency of energy use. This decline continued through 1966 with only occasional interruption. From 1966 to 1970 however, a reversal in the trend took place, causing some concern among those worried about the long term adequacy of energy supplies. A rising energy/GNP ratio would indicate the need for ever greater quantities of energy to produce a dollar of GNP. This possibility is a major preoccupation of certain advocates of limits to growth.

In 1971, however, the energy/GNP ratio again turned downward and declined in both 1972 and 1973. Estimating how this relationship will evolve over the coming several years is fundamental to any forecasts of energy demand, costs, and balance of payments impacts. If we consider the marginal energy/GNP ratio, we can talk in terms of growth rates. Thus a declining energy/GNP would be associated with lower annual percent increases in energy consumption than in real GNP.

Now that energy costs have taken a quantum jump, and concern with the wise use of energy has become universal, we can probably anticipate that the ratio of energy growth to GNP growth will tend to remain less than unity, at least for the next several years.

While we can expect the marginal ratio to remain below one, we cannot reasonably expect it to demonstrate a declining characteristics. the nature of our economic growth over the next couple of decades probably excludes such a possibility. The fact, for example, that we are going to be an investment oriented society will certainly tend to produce stability in this ratio.

Some excellent examples of the stability of relationship between economic indices and energy use can be found in the electric power sector of the energy economy. One is the remarkable correlation between personal income and KWH consumption per capita as shown in figure 1.

The FRB index of industrial production and the level of KWHR sales to industrial customers provides another excellent correlation. This is apparent from the information in figure 2. To calculate this correlation, however, an important adjustment has been made to the industrial electricity consumption data. Use by the Atomic Energy Commission's gaseous diffusion plants has been deducted from the total. Over the past 25 years, KWHR consumption by these installations has accounted for as much as 20% of reported KWHR sales to industry in a given year. Since most of the AEC use was for defense production and did not vary as a function of the business cycle, it would distort historical trends if it were not removed from the series. For the period 1956-1968, the coefficient correlation between KWHR use, (less AEC consumption), and the FRB index exceeds 0.90.

In figure 3 we have the regression line for a plot of residential KWHR sales versus Disposable Personal Income. Again, the period is 1956-1968 and again a high coefficient of correlation is evident.

(Please refer to Figure 1, 2 and 3 at end of text.)

Finally, small light and power sales, or commercial sales, correlate well with the services component of Personal Consumption Expenditures. Figure 4 shows the relationship of these two series for the years 1959-1971. In this particular case, the coefficient of correlation is more than 0.95.

III. Capital Intensiveness of Energy Supply.

The preceding information serves only to emphasize the role of energy and, more particularly, electricity in the nation's economy. It forces us to conclude that expanding our economic capability to provide full employment and raise living standards.

But what about the economic implications of expanding energy supplies?

Perhaps the most important characteristics of energy production, conversion, and distribution is that they are capital intensive. In electric power supply, for example, some $4 of net investment are required to generate $1 of annual sales revenue. In the gas utility and pipeline industry about $2 of industry, the ratio is near $1.25 to $1.

Figure 5 compares sales turnover to assets in 1971 for a selection of energy and other industries expressed in the number of years necessary for sales to equal assets.

One can see that in manufacturing industries much less investment is required to back a dollar of annual sales, the average being a little over 80 cents. For motor vehicle production, it is less than 70 cents.

Capital intensity means that fixed costs are especially important to energy industries and the cost of capital is a major factor in price determination.

(Please refer to Figure 4 and 5 at end of text.)

174

IV. Capital Requirements for Moving Toward Self-Sufficiency.

The recent experience with energy shortages arising from the Arab oil embargo has convinced most Americans of the need to minimize dependence on foreign fuel sources. As you know, the Federal government has launched a program, called Project Independence, with the goal of national self-sufficiency in energy, and a little later, I shall say more about this program and the concept of security of supply.

For the moment, however, I believe it is worthwhile to reflect on the possible cost of such an effort.

One estimate of the investment that would be required as part of a move towards self-sufficiency was published by the National Petroleum Council at the end of 1972. At that time, much higher levels of energy demand were being projected for the future than are now considered likely. On the other hand, the NPC did not foresee complete self-sufficiency even by 1985. They did try to delineate the maximum possible output potentials of the domestic energy industries and place a price tag on the achievement of these potentials. The estimates in figure 6 are based on the NPC evaluations.

In the left hand column are the NPC's forecasts in billions of 1970 dollars for the 15 years 1971-1985. The only thing not included in the NPC total was investment in electric distribution plants. I have added my own estimate for that item in order to arrive at a more complete figure. I then scaled up these values by 25% in order to place the estimates on a 1974 dollars basis. To do this, I have assumed that the GNP implicit price deflator will have risen by 25% in the four years 1970-74.

Some interesting observations can be gleaned from these numbers:

First, the electric utility industry is expected to account for more than 50% of the total investment.

Second, the finding, development, production, and transportation of oil and gas will probably account for most of the balance.

Third, coal production and transport, though important elements in any long range plan for self-sufficiency will take a relatively small portion of the total outlay.

Finally, if one compares the 1974 dollar total of nearly $880 billion with an estimate of total U.S. investment in industrial plants and equipment over the same time span, it is apparent that nearly 30% of the latter will be devoted to energy supply.

Again, a word of caution in interpreting these figures. The NPC's projection was not based on achieving self-sufficiency by 1985. It rather sought to cost out the maximum feasible rate of production expansion that seemed possible based on circumstances as they appeared in 1971 and 1972.

(Please refer to Figure 6 at end of text.)

Finding the capital to cover an investment program such as the one outlined here is going to be a key element in the eventual success of Project Independence or any other attempt at reducing the nation's exposure to foreign supply interruptions. Normally, a large portion of a business' capital expenditures are financed by internal funds generation; that is, from retained earnings, depreciation, tax credits, etc. The energy industries, being capital intensive, have to look to external funds, however, for a much larger share of their financing.

In the past, the petroleum industry has borrowed to finance roughly 1/4 of its capital outlays and the coal industry a somewhat larger percentage. In the future, however, both will probably have to rely on the capital markets for a larger share of their new capital despite current levels of earnings.

The gas utility industry has traditionally obtained about half of its capital requirements from external sources and will probably continue to do so.

The electric utility industry has been the most dependent on capital markets of all the energy industries, with external financing averaging nearly 60% of the additions to the capital structure. In years of particularly heavy investment, however, this figure has climbed to nearly 70%. On balance, it would appear that the energy industries will have to seek approximately 50% of their new capital requirements in the nation's money markets over the next 15 years.

V. Cost of Capital.

Obtaining these funds will necessitate earning adequate returns on investment, something which is proving difficult to do in spite of significant price increases for all forms of energy. This difficulty is due in part to the inflationary pressures on operating costs but it is also due to the fact that an adequate return is, today, a moving target, one that is moving upward. Of course inflation is affecting the cost of capital like the cost of everything else, but increases in interest rates for long term debt are also a reflection of the growing scarcity of capital relative to other resources in our economy. As I've noted, we are going to be an investment oriented society over the next several years whether we like it or not. Too many collective decisions have already been taken which preclude any other eventuality. We have decided to rebuild our cities, improve our environment, upgrade our housing, increase our level of energy self-sufficiency, and in general, do a host of things requiring large inputs of capital. To generate these funds, returns to capital must be higher than they have been over the past 15 or 20 years.

Some experts have suggested that in order to cover the country's investment needs over the next decade or two, our average savings rate will have to climb from 6 1/2 to 8 1/2 percent of disposable income. Such a secular adjustment can only be made in a free society by increased rewards to savings relative to consumption.

Periods of high investment and high interest rates are not unknown in American history. In fact, I was surprised the other day to learn that shortly after the Civil War, during the railroad building boom, high grade railroad bonds were yielding more than 10%, which is slightly above what the highest rated utility bonds are fetching today.

Higher costs for borrowing will mean higher costs for risk capital and, in the energy industries, risk may be unusually great in the coming years. We are intent on introducing many new technologies, all at the same time. Some of these will not pan out and there will be financial losses. Thus, the equity investor who shoulders these risks is going to expect a commensurate return.

VI. Project Independence.

I have already alluded a couple of times to Project Independence which is aimed at energy self-sufficiency by the end of 1980. To achieve this goal, the government foresees both a marked reduction in the rate of growth of energy use and a significant increase in domestic energy supply.

Considerable doubt has been expressed in many quarters as to the feasibility of achieving self-sufficiency by the 1980 target date. While the planned increase in energy supply might be attainable, the reduction of energy consumption growth to the projected 2% per year seems very doubtful. We will have to continue to expand our economy vigorously through 1980 if we are to absorb the large number of new entrants to the labor force which our population statistics tell us are coming. Even with heavy emphasis on conservation, a minimum annual average growth in energy use will probably be on the order of 3%. This implies an energy growth/GNP growth ratio of 0.75, if we accept a figure of 4% per year as the real GNP growth necessary to assure reasonably full employment.

It is interesting to note that from 1950 to 1965, a period when the energy/

GNP growth ratio was consistently below one, it averaged some 0.77. Since 1965 it has averaged something over 0.88, although in the years 1965 to 1970 it exceeded 1.5. Thus, an estimate of 0.75 for the next several years would appear to recognize a considerable amount of conservation.

In figure 7, I have indicated what I believe might be a reasonable pattern of energy development in the U.S. over the next 16 years. It assumes a 3% per year growth in primary energy use through 1990, while also including a steady move toward greater security of supply. For the period through 1980, which is also the most critical time span, it implicitly assumes the following:

* a new domestic oil price in the range of $7-8/barrel and Alaskan supply at 2mm B/D in 1980.
* a softening of international oil prices.
* a rate of growth of coal output of only 3.5%/year reflecting the strict limits on surface mining which appear to be forthcoming.
* a controlled raising of natural gas prices at the wellhead.
* a rate of increase of nuclear generation which anticipates some further slippages in installation schedules and counts on only about 90,000MW being in service in 1980.
* little if anything in the way of additional geothermal or exotic source fuel supplies. These, by the way, I've lumped with hydro.

What then can we conclude from these numbers?

First: Our gross exposure to foreign supply interruptions will be marginally higher in 1980 than it is today.

Second: The new domestic oil production likely to be brought on stream will probably just offset the depletion of existing fields.

Third: The impact of oil imports on our balance of trade in 1980 may be no worse in absolute dollar terms than it will be this year if, as I suggested, international oil prices do slip somewhat.

Fourth: And this may not be readily apparent, the worst years for both supply interruption exposure and negative trade effects will probably be between 1975 and 1978.

After 1980, the figures suggest that our gross exposure to interruption by foreign energy suppliers should decrease because domestic supplies will account for a steadily increasing percent of the total.

You have probably noticed my reference to a gross exposure to interruption by which I mean the percent of our total energy which is imported.

Our effective exposure should be less than our gross exposure. Why? Because we should be able to anticipate the emergence of several new oil suppliers in the world energy market over the next 15 or 16 years. None of these are likely to be as large as the Middle Eastern countries, but their presence in the world supply arena will tend to reduce, at any point in time, the overall risk of interruption.

The more we diversify our import sources, the more we can minimize risk of interruption. The principles that apply here are similar to those governing the management of an investment portfolio. Thus, for example, the addition of a new supplier to our source portfolio can help reduce the overall risk. Even should he be a risky supplier, if his whims are not positively correlated with those of the Middle East, he will tend to improve our security of supply.

(Please refer to Figure 7 at end of text.)

VII. The Importance of Electrification.

One of the key elements in any strategy to increase our degree of self-sufficiency will be the greater use of electricity. There are several reasons why electricity has an indispensable role to play. The need to eventually reserve oil and gas for those uses in which their application is absolutely essential means that uranium and coal will be called upon to cover a growing share of the nation's total energy requirement. Uranium, of course, is almost exclusively dependent on electricity generation as a means to tap its potential, and electricity generation offers the most effective means of developing a major reliance on coal. By conversion to electrical energy, coal can be used to supply almost the entire spectrum of end uses, including land-based transportation, and processes for the low BTU gasification of coal will permit its use for power generation in a manner compatible with maintaining high air quality standards. In addition, the possibility of using such gas to fuel combined cycle generating units could lead to a reduction of thermal strains on the environment. This latter prospect, plus the other benefits of more efficient generation, make the combined cycle an attractive target for further development efforts. Research directed at improving aviation and marine gas turbine technology will undoubtedly produce results which will ultimately contribute to these efforts.

As we look very far into the future, the logic of choosing the electric route for our energy economy becomes even more compelling. Nuclear fusion, with its enormous promise, will have to be harnessed in central electric generating stations. Similarly, effective, large scale use of geothermal energy presumes its conversion to electricity.

In addition to the potential for harnessing many new energy sources which electric generation technology will allow us to realize, two important applications of electricity may have profound implications not only for energy conservation but for protection of the environment as well. These applications are the electric heat pump and electric propulsion. Heat pumps offer the possibility of using energy resources for space heating much more efficiently than the direct burning of gas and oil. Considerable effort is being devoted by equipment manufacturers to further perfect these machines and we have good reasons to believe that their role in energy use will be extremely important by the end of the century. I might also note that the heat pump offers one of the most effective ways of using solar energy that we know, although this is rarely described as such.

Electric propulsion is another long term prospect for improving the efficiency of energy use while reducing environmental strains. You are all familiar, I am sure, with the arguments made on behalf of electrified mass transit. However, there are also many benefits to be gained from electrification of main line railway operations since electric locomotives can use energy with an efficiency equal to or greater than diesel units. Moreover, electrification permits the indirect powering of freight haulage with nuclear energy.

Electric road vehicles are still in various stages of development but we feel confident that their use will one day become common, especially in urban areas. The advantages they could offer in the way of reduced exhaust emissions in crowded cities are obvious, and from an energy use point of view, they promise overall efficiencies as good as internal combustion engines, especially engines fitted with pollution control devices.

VIII. Possible Acceleration of Electrification and Energy Use Growth At The End of The Century.

In my discussion of the growth of energy use through the year 1990, I postulated a rate of increase of 3%/year. During that period, electric power generation would be increasing its share of all primary energy consumption from about 26% currently to 35% in 1985 and over 40% in 1990.

What about the post 1990 period? Most forecasts beyond 1990 see electric generation continuing to increase its portion of total primary energy use to say 50% in 2000, but at the same time foresee a dampening of overall use growth. I would like to be a heretic and suggest that there might be an acceleration in the use of energy, at least for a decade or two, around the turn of the century. I justify this suggestion on the grounds that the United States may face a chronic labor shortage during those years due to the draconian reduction in fertility rates we are now witnessing, plus the inevitable demands for earlier and earlier retirements and shorter working hours.

Although total population is almost certain to grow until well into the next century, the portion of the population that is economically active could decline considerably. Those who will be engaged in the work force will undoubtedly be confronted with a heavy and growing tax burden to finance the transfer payments to the inactive citizens. These citizens will, for the most part, be retirees, a reflection of the likely "older" complexion of the population. Their political influence may be considerable and, as a consequence, we could expect that the level of social security they will receive may be quite high.

To bear this potential tax burden and provide a decent net income for himself and his family, the active worker will have to be very productive, and as we have already noted, increased productivity of labor has meant essentially increased energy use. In the high technology environment which presumably will prevail at the end of the century, the increased energy used will most likely be electricity.

The importance of electric power use in increasing productivity can be appreciated from the final two charts. The first (figure 8) shows how the amount of electricity used per manhour in the manufacturing industries increased over the period 1920-1971. Figure 9 indicates how over the period 1961-1971, manufacturing output rose by some 60% although the net increase in the number of production workers in manufacturing was less than 12%. As can be seen, the consumption per worker rose by about 50%.

IX. Summary.

My comments today have been far from a complete coverage of the economics of energy. I do hope, however, that I have succeeded in highlighting those aspects of the topic which are necessary for understanding both the importance of energy use and the economic costs that it entails.

In summary, I would stress the following three points:

1) Increased energy use has been and will continue to be inextricably linked to the betterment of man's economic, social, and moral well-being.

2) The finding and harnessing of energy resources are capital intensive activities and in the current period of our national economic history, mobilizing the necessary capital will require higher returns to investment than have been normal over the past quarter century.

3) Increasing the degree of national self-sufficiency in energy and our overall security of supply is possible though the time required to attain total or near total self-sufficiency may be greater than presently envisioned.

(Figure 8 and 9 attached)

QUESTION AND ANSWER SESSION

"The Economics of Energy"

Speaker: Jack L. Schenck

DELEGATE: I have a question on the third to the last slide (see figure 7) on coal production in 1990. On the chart there is no significant increase in the coal percentage use. Other people have come here and told us they thought there would be a significant increase in the use of coal because Americans have such a large supply of it. But you don't show any significant increase. Now do you include liquification or the gasification of coal in a different area from the gas, at all?

SCHENCK: No.

DELEGATE: Then what's your reason for keeping coal at a steady percentage?

SCHENCK: I'm suggesting that coal consumption in terms of heat content will go from 14 quadrillion BTU's, or 14,300 trillion BTU's to 24,800 trillion. So, in 16 years time this means about a doubling, or not quite a doubling, which is rather a significant expansion in consumption. In tonnage terms, it will mean an even larger increase because as we expand our coal production, we are going to lower heat content coal. So to double the number of BTU's supplied by coal, we have to more than double the tonnage.

The western coals which we are looking to for large new sources of energy supply, primarily because of their low sulphur content, are fairly low heat content coals too. Compared to the coals found in West Virginia and Kentucky, they may have only 3/4 the heat content, 9 or 10,000 BTU's per pound compared to 12 to 14 thousand for the good coals in the East. So that the tonnage, the material that is going to have to be dug out of the ground, will go up by a faster rate than is implied here. But, as I said, this is my forecast. It's not the forecast of my organization. For the period to 1980, the 3 1/2% looks, I think, quite hopeful, as a matter of fact, because restrictions on strip-mining are going to hold down the rate of growth. Although the strip-mining bill has not been enacted, I think we have to assume that it will be.

DELEGATE: Yes, but if we have a blackout there won't be anymore restriction on strip-mining.

SCHENCK: First of all, we're not going to have a blackout. If we have a coal strike this autumn, however, it might cause some real problems this winter, especially if the winter's cold. I don't think the price of oil is going to go up much higher than it is today. There is an interesting reason for speculating on this. The most wealthy oil producer in the world in terms of reserves and in terms of potential for increasing production is Saudi Arabia. It is not in their interest to have a high price, a high world price of oil, right now. In fact, they would probably rather have a lower price. Why? Saudia Arabia doesn't need the money today. It will need the money from its oil resources perhaps 30 or 50 years from now. A high price prevailing in the world market today will induce the development of competitive sources not only of oil but of competitive energy sources and this could render Saudia Arabia's riches worthless at the moment she needs them fifty years from now. She's rather hold down the price and keep people interested in consuming oil over the long haul. The Shah of Iran has just the opposite motivation. He needs his money today because he has a country of 35 million people that's growing rapidly and his reserves aren't as great as Saudia Arabia's.

He wants to invest in his country now. He anticipates that oil, one day, might be worthless so he wants to get it out of the ground now, get the money, and invest the money in something that the nation will live on for the rest of its existence. So, there's a basic conflict of interest between these two groups and it's shown up in the Organization of Petroleum Exporting Countries (OPEC) negotiations. The Saudis have argued for low prices not because they're particularly good friends of the U.S. They've argued for it because it's in their interest and the Shah of Iran was the man who really led the move to higher prices, and it's in his interest. I'm suggesting by the way that the Saudies, because they have more oil, will win out in the end.

DELEGATE: The people from the gas companies that have been coming through have been predicting very little growth. Yet you show almost a 40% expansion in the BTU output of the gas industry, over this period, 23,000 to 35,000.

SCHENCK: Yes, almost 50%. I didn't think I was more optimistic than they were. I've looked at some of the figures generated by other sources and given the fact that some of the offshore areas in the northeastern part of the U.S. apparently have a good promise for holding gas, and on the assumption that these areas are opened for development, I have in effect been optimistic and suggest that the level of gas output would rise considerably by 1990. I am interested in the fact you suggest they are not that optimistic.

DELEGATE: I did some research on the elasticity of supply and demand for price increases, and generally, the stuff I saw said that in the short run the relationship was a 1% increase in prices which would probably yield about a 1% increase in supply from changes in withdrawal rates, but that isn't what I'm trying to get at now. They said that in the long run an economist should realize that the supply curve is farther out in the elasticity. It has greater elasticity over the long term. What I want to ask you about is the material I've been reading concerning the OPEC countries which says that most economists right now believe that because of the cartel nature there is a large incentive to cheat. In other words, they're going to be offering oil at a lower price than what their stated cartel price is. Do you have any comments on how long the cartel's going to last? From what I've been reading, most economists now say maybe two to three years before it totally collapses.

SCHENCK: I suggest a softening in oil prices by 1980. The predictions of the demise of the cartel have been made now for about five years, and it still hasn't really gone under, has it? Undoubtedly, the incentive to cheat is there and especially if prices start to soften, simply because of world demand slags or slough offs. If prices start to soften then there will be a temptation to cut the price a little lower and produce a little more, if you can get the customer.

I think we have to keep in mind that the number of sovereign oil consumers in the world today is fixed. Every nation is an oil consumer. Most of the developing countries are much more dependent on oil for their commercial energy than we are because they have never consumed anything else. They moved right into the oil economy. That number is not likely to increase unless we have a few new nations created. On the other hand, the number of sovereign oil suppliers in the world is almost certain to go up. We know already that a very large new source is going to be available in just a couple of years: Western Europe. The North Sea just keeps turning up more and more oil and no one is really willing to draw the line and say this is what we believe the maximum from the North Sea will be. So there's one source we know that could become significant.

The West Coast of Latin America is another. Ecuador and Peru are increasing their production rather rapidly and becoming significant suppliers to the U.S. All of the Southeastern parts of the Eurasian land mass from China down to Indo-China around to Thailand are considered very promising areas. The only reason they haven't been explored is because of the political difficulties involved.

A few months ago, there was the scrap between the South Vietnamese and the Chinese Communists over some islands off the coast of South Vietnam. The only reason anyone is interested in these islands is because the Continental Shelf around the islands promises to hold a lot of oil. If finds should be made there, this could become a significant new area of supply. The Northeastern U.S. and Canadian offshore regions may turn out to be important oil and gas producing areas, too. All of these new entrants into the supply side of the equation would tend to diminish the strength of the cartel and the temptation to cheat would go up accordingly.

DELEGATE: You mentioned that during the week of July 5 to July 11 twenty nations issued their supply percentages. Offhand, do you know what nations they were?

SCHENCK: I mentioned the largest was Iran about 20%, Nigeria second at about 18% and the next two largest suppliers were Canada and Venezuela, both at about 10 1/2%, and then you drop down to the middle Eastern countries; Saudia Arabia at 6% and then a whole string of little countries supplying 1 to 1 1/2%, such as Ecuador and Peru in South America as well as Portugese Angola, Gabon in Africa and Trinidad in the Caribbean. These figures are published every week by the Federal Energy Administration (FEA) in their newsletter. A very interesting thing to follow is that the refined products come from an even larger array of countries, but you cannot be sure whether the original crudes have or have not come from the Middle East.

Figure 1

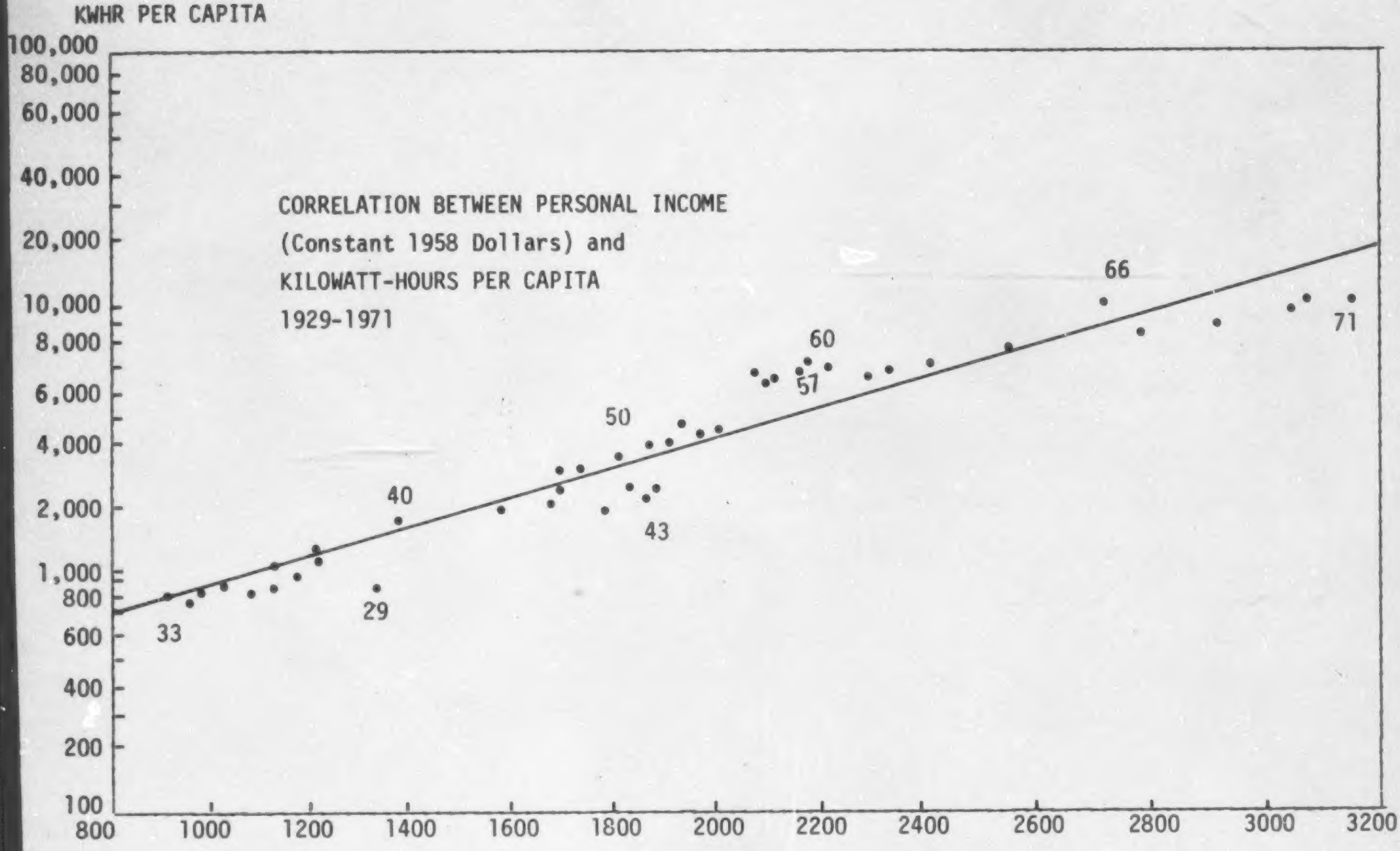

KWHR PER CAPITA
100,000
80,000
60,000
40,000
20,000
10,000
8,000
6,000
4,000
2,000
1,000
800
600
400
200
100
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200
CORRELATION BETWEEN PERSONAL INCOME
(Constant 1958 Dollars) and
KILOWATT-HOURS PER CAPITA
1929-1971
33
29
40
50
43
57
60
66
71

Figure 2

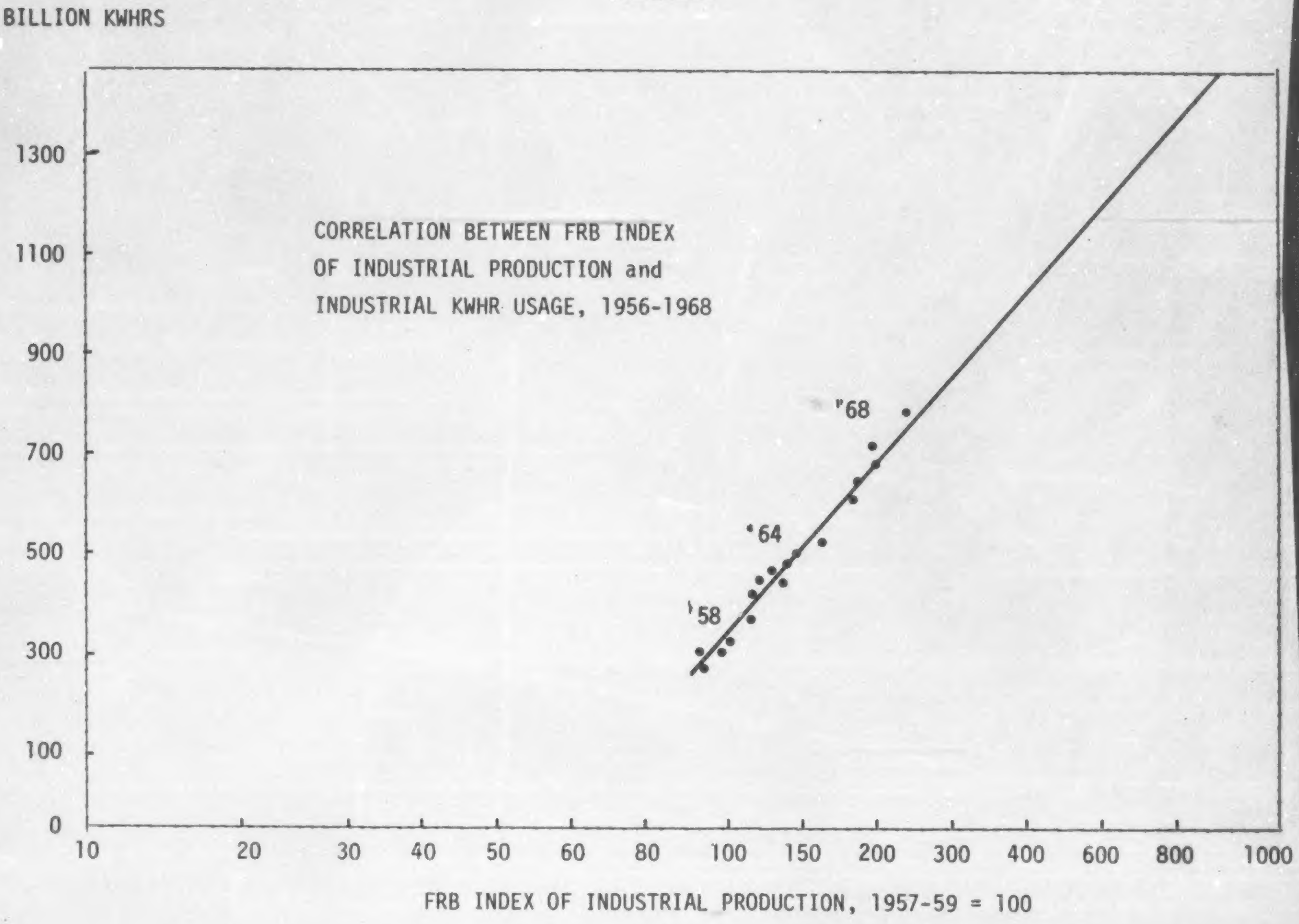

BILLION KWHRS
1300
1100
900
700
500
300
100
0
CORRELATION BETWEEN FRB INDEX
OF INDUSTRIAL PRODUCTION and
INDUSTRIAL KWHR USAGE, 1956-1968
'68
'64
'58
10
20
30
40
50
60
80
100
150
200
300
400
600
800
1000
FRB INDEX OF INDUSTRIAL PRODUCTION, 1957-59 = 100

Figure 3

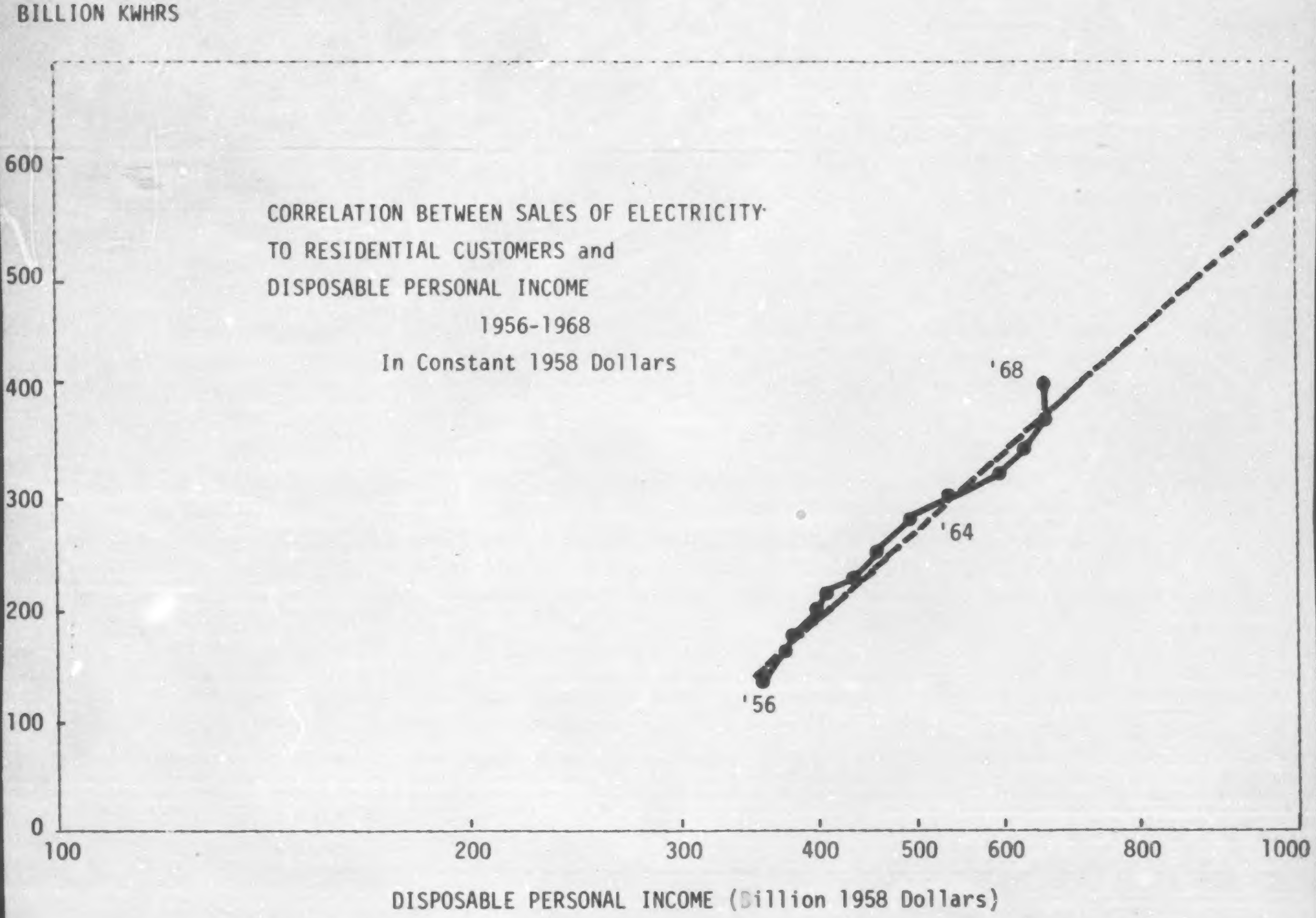

BILLION KWHRS
CORRELATION BETWEEN SALES OF ELECTRICITY
TO RESIDENTIAL CUSTOMERS and
DISPOSABLE PERSONAL INCOME
1956-1968
In Constant 1958 Dollars
600
500
400
300
200
100
0
'68
'64
'56
100
200
300
400
500
600
800
1000
DISPOSABLE PERSONAL INCOME (Billion 1958 Dollars)

Figure 4

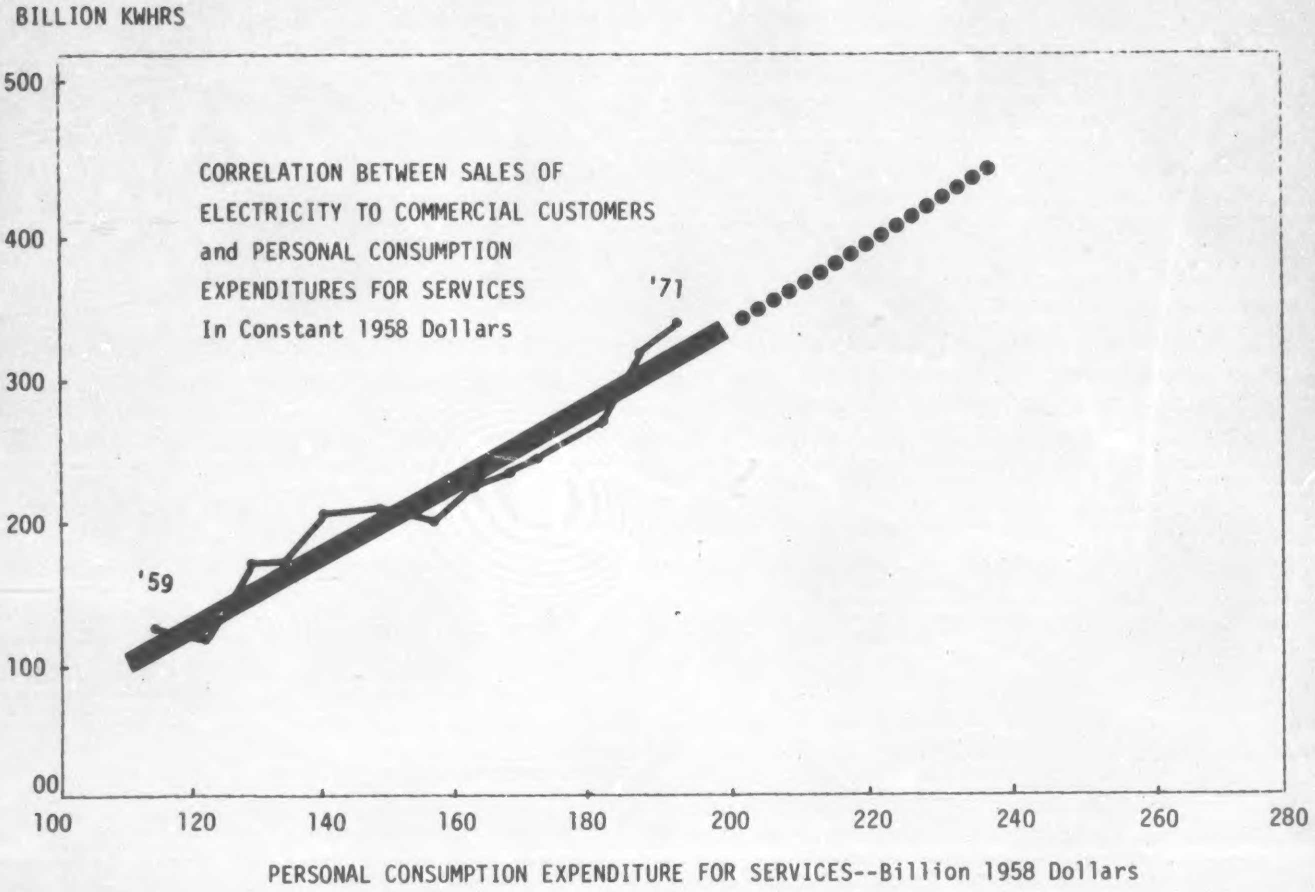

BILLION KWHRS
500
400
300
200
100
00
CORRELATION BETWEEN SALES OF
ELECTRICITY TO COMMERCIAL CUSTOMERS
and PERSONAL CONSUMPTION
EXPENDITURES FOR SERVICES
In Constant 1958 Dollars
'71
'59
100
120
140
160
180
200
220
240
260
280
PERSONAL CONSUMPTION EXPENDITURE FOR SERVICES--Billion 1958 Dollars

Figure 5

COMPARISON OF SALES TURNOVER TO ASSETS IN VARIOUS INDUSTRIES FOR 1971

Classification	Revenue Equals Assets*
Investor-owned electric utilities	once every 4 1/4 years
Communications	once every 2 5/6 years
Railroads	once every 2 2/3 years
Investor-owned gas utilities and pipeline industry	once every 2 years
Primary iron and steel	once every 13 months
Chemicals and allied products	once every 11 months
Tobacco manufactures	once every 9 months
Motor vehicles and equipment	once every 8 months
Food and kindred products	once every 6 months
All manufacturing corporations	once every 10 months

*Average net assets for the year.

SOURCES: EEI Statistical Year Book; Moody's Public Utility Manual; Association of American Railroads; Gas Facts; Federal Trade Commission--Securities and Exchange Commission Quarterly Financial Report for U.S. Manufacturing Corporations.

Figure 6

SUMMARY OF CUMULATIVE CAPITAL REQUIREMENTS
U.S. ENERGY INDUSTRIES 1971-1985

(Based on National Petroleum Council Estimates)

	Maximum Domestic Supply Capability	
	Billion 1970$	Billion 1974$
Oil and Gas		
Exploration & Production	171.8	214.8
Oil Pipelines	7.5	9.4
Refining	19.0	23.8
Gas Transportation	56.6	70.8
Tankers, Terminals	2.0	2.5
Subtotal	256.9	321.3
Synthetics		
From Petroleum Liquids	5.0	6.3
From Coal (Plants Only)	12.0	15.0
From Shale (Mines & Plants)	4.0	5.0
Subtotal	21.0	26.3
Coal		
Production	14.3	17.9
Transportation	6.0	7.5
Subtotal	20.3	25.4
Nuclear		
Production, Processing, Enriching	13.1	16.4
Total All Fuels	311.3	389.4
Electric Generation, Transmission	235.0	293.4
Water Requirements	1.1	1.4
Total Energy Industries (NPC Estimates)	547.4	684.2
Electric Distribution	157.0	195.0
Total	704.4	879.3

Estimated Total U.S. Investment in Industrial Plants & Equipment 1971-1985
$3000 billion

Figure 7

Possible Evolution of U.S. Primary Energy Consumption 1974-1990

(Trillion Btu's)

		1974	%		1980	%	
Oil	Imported	14,000	18.4	7.0 mm B/D	17,750	19.6	8.8 mm B/D
	Domestic	20,000	26.3	10.0 mm B/D	20,000	22.0	10.0 mm B/D
Gas*		23,500	30.9		27,000	29.8	
Nuclear		1,500	2.0		6,000	6.6	
Hydro & Other		3,000	4.0		3,250	3.6	
Coal		14,000	18.4		16,750	18.4	
Total		76,000	100.0		90,750	100.0	

		1985	%		1990	%	
Oil	Imported	18,300	17.4	9.1 mm B/D	13,200	10.8	6.6 mm B/D
	Domestic	20,000	19.0	10.0 mm B/D	20,000	16.4	10.0 mm B/D
Gas		30,000	28.5		32,000	26.2	
Nuclear		13,000	12.4		25,000	20.5	
Hydro & Other		3,500	3.3		4,000	3.3	
Coal		20,400	19.4		27,800	22.8	
Total		105,200	100.0		122,000	100.0	

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* Estimates of increasing domestic gas production are based on the National Petroleum Council. Case I supply scenerio as outlined in the report, "U.S. Energy Outlook" published in December, 1972.

Figure 8

KWHR'S PER MAN-HOUR USE OF ELECTRICITY IN MANUFACTURIES 1920-1971

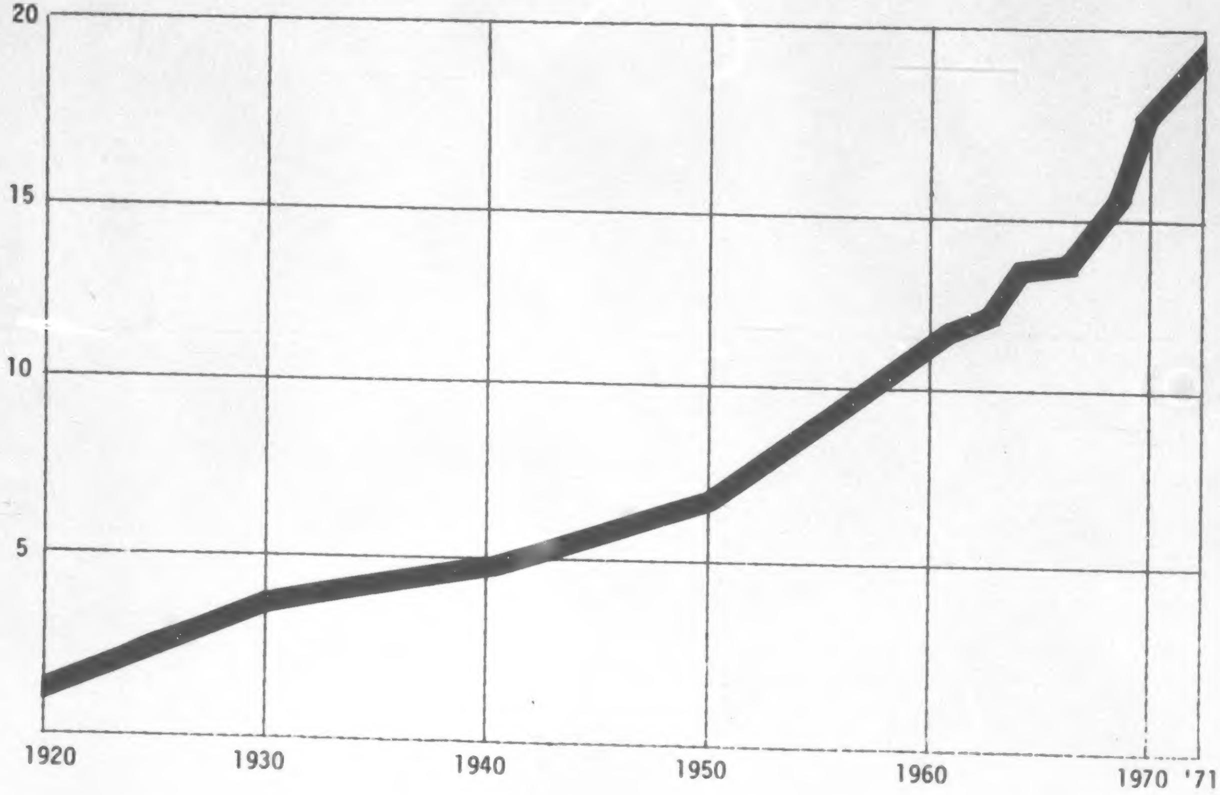
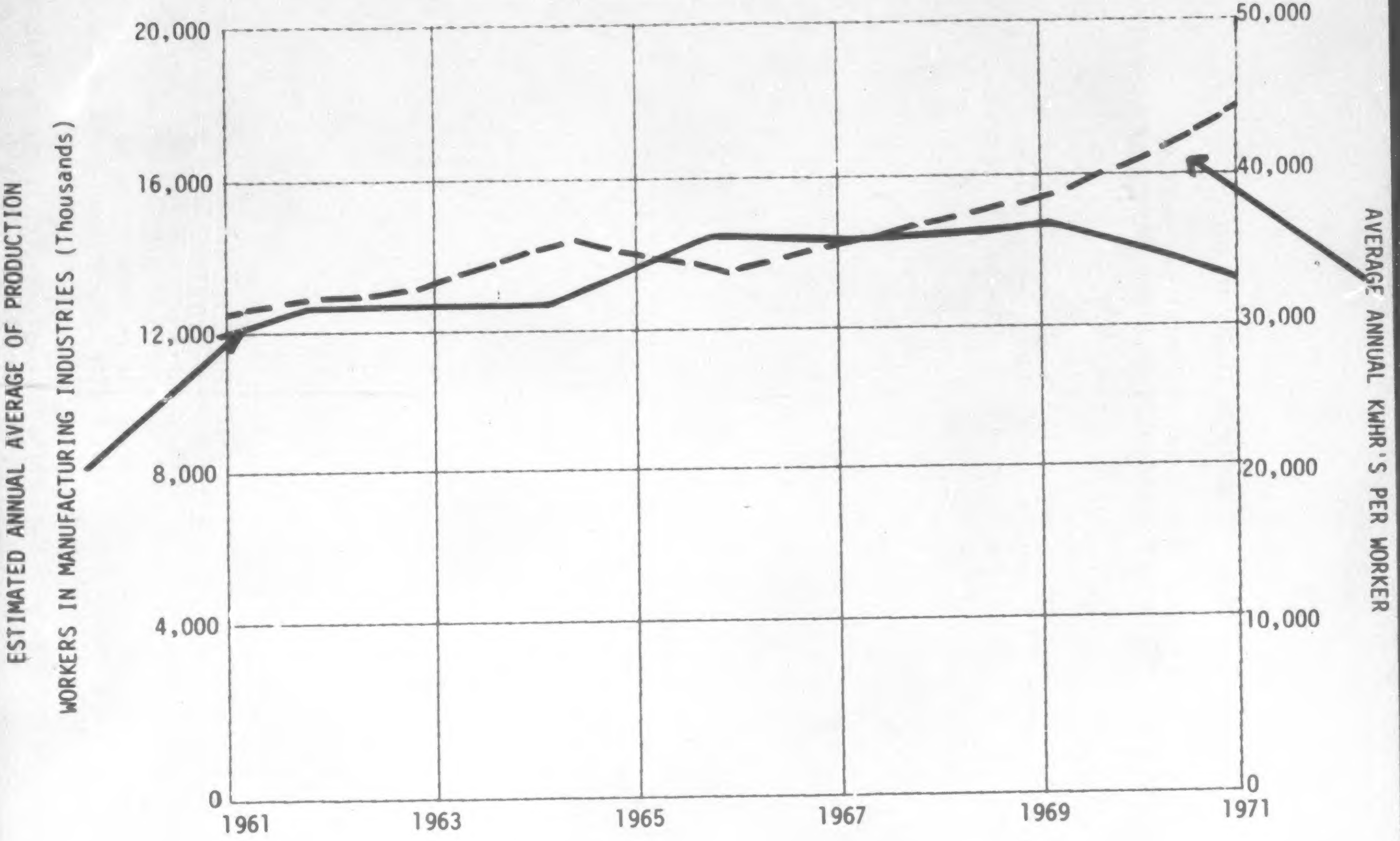


Figure 9

ELECTRIC ENERGY USED BY THE U.S. WORKER 1961-1971



TOWARDS A NATIONAL ENERGY POLICY

Kirk Hall, Science and Astronautics Committee
United States House of Representatives

I have been given what I consider an impossible task, not in a negative sense. It's just that the question was towards a national energy policy, and I sat down a couple of times to try to write a speech. I decided to send you a copy of Mike McCormack's speech and began to realize that if I had also written a speech I might sound like a parrot, repeating what he had said.

In terms of policy and philosophy, I think there are some general points of agreement. It is not difficult to decide we have got to do something, and there are some obvious choices we can select and some obvious choices we cannot select. One of the difficulties, I think, comes up as something we were talking about this morning. I can easily speak on philosophies of policy, but I think something that probably interests everyone here is what I can't speak from a podium easily on and that's what is the federal government doing, and how can we make it work better and work in a manner we feel is consistent with a policy? I'm just reflecting Congress. Another thing, I think it would be presumptuous of me, and of you, to think I am speaking for 435 people. I am very lucky if I could ever speak for the thirty I work for because they themselves represent a lot of different political factions as well as personal perceptions of what our problems and solutions should be.

I might back up a second here and point out that two of the FASST National Advisory Board members are Mike McCormack and Olin Teague, who are respectively, chairman of the subcommittee on Energy and chairman of the full committee. So, I think that you will find that our committee, and most in Congress, are fairly receptive to the concept of getting people outside of Congress involved. Be it youth, be it someone representing a utility, be it Ralph Nader, any particular group. We don't like to work exclusively within ourselves. It is best done, on an adversary system with people coming in from different points.

I think it is important here, the fact that FASST has presented testimony before our committee, among others. Now what does that have to do with policy? Sometimes it really balls things up because you are going along happily. You think you've been working with legislation that's going to solve a problem, then someone comes in and points up a difficulty. You have missed a point. You have not thought of something. An example, that has nothing to do with legislation, but I think it is a valid example with something that came up within the last year, a request by the President during the oil embargo that we try to shift to coal. In conversations with utilities, we had Presidents of utilities saying, My God, you find us the coal, we'll do it. we've been trying to do it for two years. There is sometimes a long point, a great gap between deciding what you want to do and being able to do it.

One of the problems with coal right now, apparently, is the availability of wheels for railroad trains. You've got to make shifts. Old railroad tracks in areas of Pennsylvania and West Virginia have been sitting idle and the ties have been rotting. You have to refix the rails first before you can move more coal.

This is the problem with policy. Getting from here to there without stumbling a dozen or 100 or 1000 times.

It starts first, in my point of view, with someone coming up with an idea. This I suspect is your purpose here, coming up with ideas. But, there is a great gap between the idea and its actually being implemented, being used and being useful.

On my resume you might note that I worked in the Air Force for about five-and-a-half years. I was working on underground nuclear weapons effects tests. This meant going out to Nevada, crawling around in tunnels and exploding nuclear devices, then trying to get some results from the explosion. You could always tell the new experimenter. He would come out, scratch his head and say: "I don't understand. You've only got a degree of confidence of plus or minus 25%." He then says: "That is ridiculous, that's a poor experiment. I can do better." "Fine, go ahead." So he would prepare his experiment, bring it out, put it on an exper ental array and go home. The next day a miner walking by with a 2 x 4 or something like that would knock his experiment off or would put a hole in it or damage one side of it. Then the experimenter would come back to the post test meeting with egg all over his face. My point is that a good idea is necessary but not sufficient. And I'll let that soak in for a minute. It is necessary but not sufficient. Because one can act on bad ideas as easily as good ideas. And probably carry them out as well.

So let's start with the premise that we need a good idea. Let's say that our good idea is a rational national energy policy. What does that mean? I would suspect that it means that we want to solve some problems we face. Do we just want to solve the problems we face today? I think not, I think we want to build a system that will also be able to react and solve the problems tomorrow that we haven't thought of today. One was alluded to here. Presently, one problem is energy. Tomorrow, it may be materials. It may be something even more different in terms of rates not just quantitities. Five hundred years of coal is useful but if it takes us five thousand years to get it out, it will not meet shortfalls in other fuel sources. So, there are other problems that are less apparent or are secondary but can stop the apparent idea from even being easily or altogether solved.

If we move from that point, what things in an energy policy do we want to look at. I'm just going to name a few just to give an idea. One that has come up recently is called net energy. Does our policy account for getting out more energy than we are going to invest in a new technology, resource discovery, or resource exploration and discovery? Then what about equipment replacement? When we develop new technologies, can we get them on line, both in a technical sense and secondarily, in an economic sense.

It's well and good to have the technology here for solar heating and cooling of houses but if a person has just bought a home and invested a great deal of money in electrical equipment in his house which works; and if he lives in the northwest, is it cheap enough for him to use? In one respect, you may have to wait until he decides to buy a new house or his equipment wears out to really ask him or tell him to put on solar heating and cooling units, unless you give him some sort of incentive to do it beforehand. This then works into another area I call non-energy economics. The sort of social attitudes and laws which will affect our policy choices in energy and cause a problem as a result of the economics or societal patterns. These are all intertwined.

Again, the example is a person buying a home. Say it costs $2,000 to put on a solar heating and cooling unit, $2,000 additional to the cost of a home. First, the purchaser may pierce the ceiling of a loan limitation, if he is trying to get some financial aid with a loan program, and then be ineligible for a loan or a loan guarantee. Worse yet, he might have to cut off $2,000 somewhere else in his house to make up for it. So he does that in insulation, let's say. Great, he's got a solar heating and cooling unit in a house that takes more energy to heat or cool, and he's got probably no better than he began with. Worse yet, he comes up to pay taxes and finds out that for the lifetime of his house, he's paying on $2,000 a year more value to the house due to the solar heating and cooling unit. Why should he do it? Why should I do it, if all I'm going to have is an obvious additional payment? It is a big block that counters any conceivable future savings.

We need to start preparing ourselves for changes either in terms of incentives or life styles to reflect the policy changes or policy direction that should reflect what people need or what we can rationally provide. What it comes down to in a very broad sense, I see, is that we have some choices which are obvious. We have some implementation choices which are less obvious.

I could probably talk on this subject a great deal longer, and obviously remain as vague to some degree as I have so far. But what I prefer to do is open it up to an interchange because in some respects a lot of it has to do with your perceptions of what you see Congress or the Executive doing. I can't answer this well, but I'll always stick my foot in my mouth and try.

We've got Dave Jenkins here and Tom Hunt back there that have worked with me from different viewpoints as well. I think it would be helpful to talk about it in that manner. Let's have an interchange. Throw out your ideas, what disturbs you about the way Congress does or does not handle something. I might give an example of just one thing, the half-life of a person working in Congress is about three years, meaning someone like myself. But the half-life of problems, getting a major piece of legislation through, is often greater than that. So you often have people working on problems that are longer than their lifetimes in the sense of the job.

You often have to work on a problem when you know you are probably going to leave and it's not going to be finished. It's a little bit different than being able to sit in a laboratory and work something to its conclusion good or bad. You often leave with an indefinite feeling as to whether you have done anything. So, with that I'll finish, and let's go to some questions. And don't direct them just to me. I think we should all try to answer them.

PANEL DISCUSSION
"SCIENCE AND TECHNOLOGY LEGISLATIVE PROCESSES, AND YOUTH PARTICIPATION"

Panel Members: Kirk Hall, Science and Astronautics Committee,
United States House of Representatives; and
Thomas E. Hunt, Washington Media Representative,
Atomic Industrial Forum; and
David Jenkins, Assistant to the Chairman, United States
Atomic Energy Commission

DELEGATE: In Congress, one goes through a large number of committees and subcommittees and what not in the various houses of Congress, and although a certain degree of inefficiency was built into our two-house system in order to provide for discussion of all the issues involved in each bill, doesn't the large number of subcommittees and committees that are currently needed now to go through a bill overkill them? Is there anything being done to streamline the process?

HALL: I wouldn't be surprised if Dave Jenkins could spend his life writing testimony for his boss (Chairperson, Dixie Lee Ray, the Atomic Energy Commission) because of that. But, there is a problem with that. The last time Congress, the last time the House organized itself, was in what--1946, 1947? Okay. It was organized at that time for problems the country faced in 1946 and 1947. Two obvious ones we're aware of that they didn't face were energy and the environment. What happens in that case then, is that those two problems cut across jurisdictional lines, and you have people looking at various elements; you have the Joint Committee looking at those involved with nuclear, but yet they carry over into other things. Within the budget, the last two years have been geothermal energy which they look at, as does our committee. And you have fossil fuels and interior. Our committee is responsible for the budgets of the National Science Foundation and NASA, plus a general overview of science R & D. So, as a result, our work has been primarily in geothermal and solar energy in terms as it involves this particular crisis.

HUNT: Thirteen committees, isn't that right?

HALL: Some number greater than five. More than you would want to have to face.

HUNT: Some thirteen committees in the House of Representatives have energy jurisdictions today, and we're currently, or the House of Representatives is currently, in the throws of reorganizing itself, and Kirk, maybe you are closer to that than I am. I know that the speaker during the last session of Congress appointed a special committee on committees headed by Congressman Richard Bowling of Missouri. And they took testimony to say: "Hey, how should we run ourselves?" We haven't looked at streamlining our own process for about 20 years, so it's time. We know that, let's do that. So they took a bunch of testimony, and they finally developed a streamlined set of committees so that the House could operate better. I believe the number of committees was 15 and the number of committees that each member of the House would have to serve on would be less than one maybe two, so that they could spend more of their time becoming experts in their areas rather than dividing their time over two and three committees. Under that reorganization plan, which by the way, went before the Democratic caucus and did not emerge.

DELEGATE: The Bowling plan was rejected by the Democratic caucus mainly by committee chairmen who were afraid they were going to lose too much power and the speaker called for a counter committee, the Hansen Committee, to study the Bowling plan and make recommendations for that, and now both plans are going to be fought out on the House floor. So, which one will win is unsure right now, but in either way, it appears that the House will be organized somewhat.

HALL: I will make a point that the choices made by both the Bowling and Hansen Committees follow one of the problems you have in trying to make any sort of choices. If you look at energy there are two easy choices you can make. You could group energy in a vertical sense: you could do everything from including the Federal Energy Administration (FEA) and Allocations to R & D, or you could make a horizontal break and break R & D and Allocations and Resources into two separate areas, both of which have some merit and lead to some direction. The Hansen and Bowling Committees have both chosen the horizontal break which would have a committee responsible for energy and environmental R & D and a committee responsible for energy and environment in terms of controls, regulations and actual day-to-day operation. But, here again is the problem. I'm sure we could spend days making rational arguments for both cases, but they have to come up with a choice. Now, maybe neither of those would be good 5 or 10 years from now, when they have forgotten about materials or food or something else.

HUNT: If I can just take a minute, it might be helpful to just take a quick look at the legislative process without dragging it out. If you decide that you want to make one of these decisions that Kirk was talking about and get from here to there, how does this thing evolve? Well, literally thousands of bills are introduced in Congress every year, and when they are introduced, they are introduced in the full House of Representatives. The House, the Parliamentarian, I believe, selects the committee to which that bill will be considered in. Let's say that we've got a bill that is going to be considered in the Science and Astronautics Committee. Perhaps it is a solar energy bill. So, it goes to the Energy Subcommittee on the House Science and Astronautics Committee, or it goes to the committee and is assigned to the subcommittee. If the subcommittee decides to hear it and consider it, they may or may not, they will then call for hearings. They will take testimony from many sources. Kirk, maybe you ought to take us through this.

HALL: Let's take a specific example. Friday we had testimony on what we loosely call an Omnibus Solar Energy Bill. It included testimony from the Office of Management and Budget (OMB), the National Science Foundation (NSF), the National Aeronautics and Space Administration (NASA), and Dave Jenkins' boss, Chairperson Dixy Lee Ray of the Atomic Energy Commission and Dave's got a copy of her testimony there.

JENKINS: I might add just a little on it being an agency going before a committee and being the kind of agency that AEC is. I don't know if NSF is this way, but I suspect so; we have to go under approvement of the Office of Management and Budget prior to when our testimony is to be given before we can give that testimony. Then we have to look at the bill submitted. For example, the one that Kirk mentioned that was given yesterday was the House of Representatives Bill 15612. We looked at the bill, and we looked at the parts we could agree with, and we spoke to those parts and we looked at the parts we could not agree with, and we spoke to those parts as well. A good example is the conversation on budgets that Dr. Cohen (NSF) mentioned this morning. You probably didn't pick it up. He said that we had some $600,000 that we finally got the O.K. to spend, and that's because of the way the Atomic Energy Act is stated that we must go along a certain mission. We just cannot spend money outside that mission unless we get approval to do so. Obviously, solar energy does not come under atomic energy. In order for us to do research and spend money on that we have to have authorization and to go ahead to do so. So, we prepared testimony and trotted over to the Hill yesterday to testify, give AEC's opinion on what we thought about the bill.

I might also mention that earlier we were talking about the number of committees that deal with energy, and last year we were beginning to think that everybody on the Hill was dealing with energy. You see, not only do we have to testify in the House, we also have to testify in the Senate, and we got started last year with solar energy, geothermal energy, and right down the line, at that same time, as you probably realized, we had House and Senate appropriation hearings. We got so strung out, we as an agency got so strung out, we had people over in one group testifying at 10:00, and we had people at another group testifying at 11:00. We just had people strung out testifying everywhere. An energy shortage hit us. Everybody wanted to move. The Congress realized that. People looked at feasible situations, they decided that we should move on this front, let's call in and have testimony and AEC, NSF, Department of Interior, and everybody was running up there giving testimony. Everything but foreign. We think we know the way we want to go. And all of a sudden it just slowed down. I guess that is the nature of trying to get a good idea in, a way to take that idea off the paper now that you have gathered the opinions of it and actually put it into demonstration.

HALL: The next step after a hearing comes back to the committee: There are a number of alternatives and choices. If there is an administration opposition, one decides whether you feel strongly enough about the legislation that you continue in spite of it, or you would just say we agree with you and finish it right there. If there is not an administration opposition, then the committee, based on other testimony, would decide whether they felt it was worthwhile to continue.

Let's say, that regardless of the input, it was considered worthwhile to continue. At a staff level, one of my jobs would be to try to filter in; for example as Dave Jenkins said, the AEC would speak to elements they disliked that were inadequate. I'd review that, probably even have some more conversations and try to come up with something that was workable, a compromise in many cases, which probably doesn't make anybody very happy, but at least it would work or give the flexibility to our final point of view. And here again comes one of these problems of stratifying what's important, what's most important.

If you're going to get hung up in some small element of a bill that has nothing to do with your intent, the bill may literally die simply because you have gotten people too serious about something they shouldn't be that serious about. And that always happens in any case. So, what I would do,is go around to my members and recommend a course of action and reiterate. Now, they don't sit there in a vaccuum waiting for me. They're being approached at a higher level, talked to by a number of people and thinking about it themselves. But I sort of do the technical work and make sure the words are right. We have what is called an Office of Legislative Counsel, and I go over there and make sure that things are legal.

One interesting problem I ran into recently was one of the things in a bill we wanted to do was geothermal energy. We wanted to get the point across that we wanted power plants around 10 megawatts. Fine, I went and asked legislative counsel, and it was politely pointed out to me that if I put 10 megawatts in there, that you should build a plant of 10 megawatts and the poor administrator was working and it came out 10.5; he had broken the law. So sometimes things have to be vague to give the flexibility that you want. You could define it so that nobody is going to do anything. If I were administering that, I just would not do it.

DELEGATE: I have a question which we ran into when we were trying to write up the resolutions, that is, whether we should use the word suggest or recommend.

JENKINS: Those two would make no difference.

HALL: That's my opinion, using them interchangeably, and no one has told me that legally it means any difference.

DELEGATE: Is there anything in Congress right now as to a National Energy Administration, or something like this? Could you give us some details on it?

HALL: The Energy Research and Development Administration which passed the House December 18 and Dave Jenkins probably knows more about the internal structure of it than I do.

JENKINS: Maybe I can give a little background on it. About 18 months ago, there came a suggestion that there should be Energy R & D concentrated primarily in one agency, the biggest ocean for R & D. About that same time there was talk of the Department of Energy and Natural Resources. For some reason it appears that the Department of Energy and Natural Resources was not going to be the ship that was going to take us where we want to get from point A to point B. As a result of that, someone thought about the idea that why not take the Atomic Energy Commission, split it into two parts, let one part represent the Nuclear Energy Safety Licensing Administration to handle all nuclear power plants and its regulations. Then take AEC with its laboratories, some 19 of them scattered across the U.S. and name that the Energy Research and Development Administration, commonly called ERDA. Testimony was required.

First, I should state that the Atomic Energy Commission is one of those agencies that has a joint committee that receives it, a joint committee made up of the House and the Senate. It is called the Joint Committee on Atomic Energy. AEC was created by an Act. In order to change us into anything else we must make amendments to the Atomic Energy Act. But first we had to go before the Joint Committee on Atomic Energy. We went up and had hearings and we went back. Then we went up and had more hearings and went back. And we went up and had more hearings. Finally, the Joint Committee was satisfied as to how the Act could be changed, bearing in mind of course, that the members who make up the Joint Committee on Atomic Energy also are on other committees as Kirk just mentioned. Mike McCormack, for example, likes solar energy and that part. So, besides wearing the hat of being on the Joint Committee, he wears another hat over there, and a hat over here.

Finally, the legislation for ERDA passed through the House. At the same time, the Senate was looking at the legislation as well. That meant, of course, that we had to trek up to the Hill to give testimony to the Senate. And we went up and gave more testimony to the Senate. And everybody was waiting on ERDA. It was going to be the thing. It would take parts of the Department of Interior, take parts--I don't think that there was very much from NSF that was coming over. They were pretty well satisfied with the major portion that they were going to do. But, from other areas that would be moved in, they would use a string of government laboratories with all of those people out there--maybe 1,000 of them who could look at and come up with solutions to certain of the energy problems, and have it coordinate, and we could go toward that Energy R & D.

Finally, the bill did get into the Senate, and it stayed in the Senate. As a matter of fact, it is still in there in one of those committees. I guess it was reported out of Ribicoff's Committee [on Government Operations] and is before the Senate now. Remember, that was 18 months ago. When is the ERDA bill going to get out of the Senate? Well, I understand by rumor just the other day that would be August 5, which is Monday. And by the time I got here, I heard another rumor saying it would be out on Tuesday. Tom (Hunt) was talking to me this morning. He said, "Well, I understand that the ERDA legislation should be out on Wednesday." There are those who doubt because of the way that things are going now that it will get out this week, and there are others who believe that it will. We don't really know at this point, but it does give you an idea of the way legislation moves toward coming to things.

Now, everybody agreed right off when the ERDA idea was introduced that it would be a good thing to have Energy R & D centered in one agency. We could look at short-term production of energy use, and we could look at long-range during the same time as well. On June 29th of last year, President Nixon sent a request to the Chairman of the Atomic Energy Commission to take a look at the Energy R & D. That is being done both in government and in private industry. As a result of that, he also sent a second item, a report was submitted to me by December 1, and it has become known as the December 1 Report. The title of it, of course, is the nature of the nation's energy future. Some 400 experts from across the U.S. participated in that, including those from industry and those from government who thought it was a fairly good report. That was June, it was due December 1.

About November 5 last year, President Nixon, in a message to the nation came up and introduced Project Independence and self-sufficiency. Consequently, when our report was out for comment, it came back with a lot of self-sufficiency in it, and there is just no way you can do that in terms of short term. Our report started out for long-range energy development, and it ended up with self-sufficiency for short term by 1980. There was just no way. That too has a bearing on what will be done if we ever get an energy research and development administration.

HUNT: Two other quick pitfalls in the legislative process, if you decide you want something done as a matter of priority: You heard that politics is the art of the possible and indeed it is. The Joint Committee this year considered two important pieces of legislation in line with Project Independence and getting nuclear power plants on line more quickly, and it decided that it was really important to get a new licensing bill so that we can streamline that process a little bit. At the same time, it was important for utilities that they are making commitments now for 10, 15, 20 years hence, and it takes 10 years to build a plant.

Well, we just knew that we were coming up against the impeachment bottleneck, and that it was going to have to be one or the other. The licensing thing lost out because the Price-Anderson Act was deemed to be more important because energy does not exist in a vacuum with relationship to other natural resources. In legislation it doesn't exist in a vacuum either. It's with all those other bills, consumer protection and things, and other people who are trying to jam the slot. So, there's other problems, too. I remember that when I was doing news, I interviewed a city manager, who was particularly slow, who said, "Tom, you must remember that the wheels of government grind exceedingly slow but exceedingly fine." I was very impressed by that. But his city council wasn't; they fired him. He was exceedingly slow.

DELEGATE: This group here is considering passing some resolutions, and I want to ask you gentlemen each to comment from a political standpoint, also from your personal opinion, about how effective some resolutions, or say we'll take one resolution, say we pass one resolution, what would we do with this? How would you recommend we implement this if we want to, let's make this including that we do want to advocate this position. With that conclusion what would be the best way to go about this? And then could you also comment on whether or not we should be advocating this position? I want just some general comments on this whole question because it is going to be debated in the next few days by us.

RIGSBEE (Phillips Petroleum Company Representative): One point I might make: I would suggest that you disseminate it both up and down. You want, I think, to convince Congress or your local mayor or the president of a university, a high school principal or whomever the heck you want to convince as much as you want to convince the people whose policy it is then going to interact on, that it is a good idea. Because then you get a broader base, if we utilize it, and secondly, you get more people telling that person it was a good idea and to try it. I am not sure that you just send it up. It won't do any more than come back down. You need to go both ways. Consequently, it should be written; that's the point I was sort of getting to. There is a different way you would write them, depending on which way you want to send them.

JENKINS: There is one other point, too, that I would like to bring forward. I think you are moving in the right direction. I would never be one to say whether you should or should not have a resolution. But, I would caution this fact: When you're doing a resolution on some phases of energy, because there has been so much done at this stage of the game on energy, ascertain that you know your facts. How will you know that? I'm certain, almost, that on every college campus in the library somewhere is a copy of the Congressional Record, and secondly, the Federal Register. Those will bring you up-to-date and give you leads. Then check down the actual information, the facts. For an example, I heard some reports last night, when we all went to Alexandria, that we should spread out the research into breeder reactors, fast reactors, when I know that less than eight miles from here is a room that is stored with racks upon racks on breeder technology. You name it; it is there. If it was submitted to me as in my job now that I screen it and then send it up to my boss, it would never get there. She would literally chew my head off for sending up something like that that doesn't have the facts with it. And it would only take once. It only takes once. That's humorous, but that is true.

You just finished hearing Kirk say that that is some of the things that he does in his job, and that is true. You look at it and screen it. If it doesn't have enough facts, because you have so many things to deal with, you don't have time to fool around with those that do not represent the facts. You can't go back and submit it to that office. You cannot go in and change it from the way the group had submitted it, and add the facts to it because there is another group that is sitting with one that you don't know whether it has the facts in it or not. Make certain that the facts are there, and I think that the easiest way to guide you on that is from the college library, looking for the Congressional Record and/or the Federal Register. I doubt very seriously that you would have copies of hearings, but they are available.

HALL: A point to make on that thing of hearings: You should get your libraries to start ordering hearings, which they can do. We get 10's of hundreds of 10 or 20 requests a week from libraries as matter of course just wanting to know the recent hearings. Someone would look in the Congressional Record and say, "Hey, that one looks interesting. I know they will be publishing it soon." Then they order it.

HUNT: I guess if I were to address the question, I would say don't waste your time. By saying that I don't mean, don't do it at all, but think about what you are going to do as a matter of fact. Approach it by putting yourself in the shoes of a Congressional staff member. He's got to answer your letter, let's face it. You know, you may send it up to a Congressman, and he may never see it. And if you have 16 or 21 diverse things on it, and say, gee, we recommend that you do this and that. Well, how do I answer your letter if I am that staff member? How do you answer the letter? "Thank you very much for your views. We'll be sure to take them into consideration if and when legislation is brought to the floor and remember I am your Congressman. If I can ever be of further assistance to you, do not hesitate to call on me in the future." O.K. Good letter. What have you really done to input to him? How have you helped him?

He might examine it from another standpoint. I'm not suggesting this; I'm just throwing it out. If you had 21, and you say here's a priority item, and we know that legislation exists but it isn't moving, let's take a solar bill, for instance. If you decide, resolve, that we really ought to get on that thing, then maybe then you tie it to HR 1234 because here's something you can pinpoint. You say, Congressman here's the opportunity, here's the solution to what we believe needs to be done when we met, and then you mail it.

In that sense, I'd just like to get into a pitch for your own involvement with your Congressman. I don't mean to put you on the spot, but does everybody here know who there Congressman is? If you don't, you should. If you do, that's great. You know it's fun to go in and put your hobnails on his desk even if you don't agree with him. What I'm trying to do is give a pitch for involvement.

Don't be afraid of those people. They really are there to serve you, and they really will give you a hearing if you have something legitimate to say. Yeah, they are busy, plenty busy, and they may not want to hear you, but they will because they've got a conscience too. They remember back there somewhere that they represent about 500,000 people, and you are one of them. You can do it, and I just implore you to please do it. If you have something to say, do it. Whether it is in the home district, whether you have to travel 10 miles to his district office, and every Congressman has one to four or five district offices, or you want to come to Washington, D. C., do that too. But you can find out from that office when he is going to be there and then go point your finger at him, and say, "I care, and I want you to care," and here is a vehicle.

HALL: A correllary to that is that because they are so pressed for time, they love good advice, and by good, I mean factual, timely, well done, either helping or opposing, but not prejudicial. Well done. If over a space of a year, two years, or six months, you as a group or as individuals have provided information and a point of view that they look back and say, "Hey, this is pretty good; this fellow gave me good information." Then you start having an impact. You don't do it the first time.

I mean I get a letter and unless it is signed by a Nobel prize winner, and even sometimes then, I'm not sure if it's that good. My point being that there is no reason when you first go in that you shouldn't be listened to any more than any other opinion that's wandered in and out of that office that day. I would suspect that if you want any more than that, you are fooling yourselves, and I doubt you really do. It's a point of being good and persistent. An example is when I was stationed in New Mexico, I had a friend who was corresponding quite often with Senator Clinton Anderson. He had been doing it for a number of years. This fellow wandered around the state and found areas he thought should be wilderness or reserved in some way. Pretty soon he was advising Anderson. This fellow was sort of doing leg work for Anderson. For a couple of years, he was literally advising him, and as such a couple of bills with amendments on them that Anderson tacked on specifically preserving acreage of land in New Mexico were due to this one guy. He provided good information that was backed up when Anderson asked someone else like a federal agency, and as such, Anderson began to rely on this man's opinion to the point that something substantial was done. I think it can be done by anyone as long as they keep in mind that it is the presentation of the facts as well as the demand for action that is important.

HUNT: I think it would be very effective if you each go to your own guy or woman, whoever is representing you, saying here is what we did, here is what we care about. But I am your constituent, Charlie. John (Burnett) and I were talking last night, and I think the point was well taken. Don't limit it to the Washington, D. C. area. You've got state and local people that you can hang these issues on just as well, and they are in a position to act and as he said, many, many times you are more effective working from the grassroots up than from from the top down. If you can have a handle on city hall, you can shake city hall a lot better than you can the capitol.

Also you may find that since this is an election year, it will be a lot easier to get in contact with elected representatives. And the contacts you make make now, if the person is re-elected or elected, will help out a lot in future years. But the main thing is that now before the November elections you should try to make contact, and you will find this a lot easier.

HALL: I would think one good case of this, in a political sense, and I could probably stick my foot in my mouth, is that these candidates are going to have to in some manner or another make stances either vague or more specific on energy issues. I think there's the point where in an adversary sense or helping sense if you feel you should either write them, ask questions at political rallys or whatever, and make them revise their stances and/or inspire they themselves to get the facts on it.

FRADIN (FASST National Office): They may want to appoint you as their energy expert, and you might end up writing speeches and papers for them.

HALL: That is very true. Let me add onto that one: I hope all of you listen well and I have talked to some of you about it. But it concerns us and it concerns people that are involved in the energy political process. Dave (Fradin) and I have talked about it, that is, that we have virtually one scientist in the Congress today and that is Mike McCormack, one guy with any feel for science. There is 435 of those guys, and only one can listen with a critical ear to technological arguments and Ralph Lapp said once, it really comes down to which Ph.D. you want to believe. Well, when you have those people taking hearings and taking testimony at hearings, and it's on technical matter, you are going to want somebody who can kind of discern which is grain and which is chaff. So, again, I just hope that you will not keep away.

There are those of you who will be generous, and I talked to some of you a about it, but I hope you will involve yourselves in the political process because it seems that the scientific mind in its discipline doesn't like to dirty its hands with politics which is gamesmanship. Well, we've got to get involved. I think we have to get more people with a technological background involved in the political process. I'll step off my soap box, but I really do care about that, and so do a lot of people.

JENKINS: I just have to add that if I were to do a resolution I think the best place to try it out is to find out how I am doing with the facts, the best thing that is available right now. One of the greatest things I have ever heard of right now is the regional things that's being done by FEA. You don't have to wonder what it should be about, all you have to do is pick up the list and look at what they will be discussing on these hearings in the area. Then do your resolution. Get your testimony ready and all of a sudden you are sitting right here.

It will do a number of things for you. If you believe in the Energy Youth Council, that means that you will pick somebody up from your campus in your area, and rather than leave you there with that big stack of papers to give your testimony, you've got others there. You are learning together. You are going to make your mistakes, You have a testimony prepared and it is 25 minutes and you get 5 minutes. That's all right. Do it. You're getting involved in a political process, the decision-making process, and you can move from there.

DELEGATE: I agree with that wholeheartedly. I would hope that is what we decide to do later, and I think there has been some concern that we are not well-informed enough yet to make commentary. I think that is very well taken, because I don't think that we are. That doesn't mean that we can't decide what changes we would like to address ourselves to or know which items should be tabled, or assigned to people, say between now and the next two or three months when the chief hearings are going to take place. We can circulate our commentaries, hand them back to the National Office if they have to have an O.K., and then formalize them and hand them over to these hearings as official testimony. I think, however, what needs to be done is get a consensus of those types of things and those areas in which we think we would like to make comment on. This process of the resolutions I know right now is pretty chaotic, to say the least, since for some people this may be the first time they've ever approached the idea of making resolutions. But I want to comment that when we discuss our resolutions with the other people, our advisors and our speakers who have been with us most of this week, they will be around to aslo help advise us and tell us: "Listen, that's really stupid," because of this or that and because they work on some of the things that we are saying. Obviously, sometimes we may not even be able to judge whether they are good or not.

HUNT: Well, don't put yourself down. I'll tell you, you've done more thinking about energy in the past four days than the guy on the street has done in his lifetime, I promise you, really.

HALL: There is one definite advantage in being able to see it from a new point of view. If we help you to some point, your letter may end up like 70 I have seen, and I won't be able to discern it one from the other. There is something special about a fresh viewpoint. I think Tom's point of being correct, being factual, is really the important thing. The manner in which you do it, you should retain for yourselves, and in some cases, tell other people to drop dead if they try to tell you how to write it.

DELEGATE: Well, I just meant that you could perhaps have an input because maybe we don't know enough about the factual matters to know when it is not factual. I mean you can suggest something, but if it has already been suggested or it is already in the process, maybe that's not such a good idea. Do you see what I'm really trying to say?

HUNT: Kirk was trying to tell you in a nice way that he is flying out of here at 6:00 tonight come hell or high water (laughter).

DELEGATE: And you're not going to be here tonight either, or you Tom?

HALL: Actually, Laura, I think that has to be our function. We have to get through the research and get the facts and know that this isn't something that has already come down the pike.

One of the best resources, and it was done here in Oak Ridge, was an inventory of all the energy studies going on in the United States, Energy R & D efforts which are done right here. For a number of years, Oak Ridge was known as one of the centers for energy conservation studies. You are sort of sitting right in the middle of a lot of good information. You have been all week.

DELEGATE: Concerning certain technological decisions or areas of energy policy as far as research, I think the best example I can think of would be with breeder reactors. Who made the decision to go with the Liquid Metal Fast Breeder Reactor, and in the future, who will make the decision to increase energy in one area of research and less in energy in another? Is it the AEC? Or would it be the Congress, who appropriates the money, who has the last word, but who makes the most important decision on it?

JENKINS: A few years ago when we looked at the Liquid Metal Fast Gas Breeder, the high temperature gas cool reactor experiment in Oak Ridge, Tennessee, and one other concept, we had about three to go with at that time. We also knew that five foreign countries had essentially gone through the same process looking at the eggs available in their basket. Those five countries, by the way, had decided to go with the breeders, with the liquid metal breeder, and there were some others in England with a different breeder type, but they were still interested in the breeder. We knew what most of the foreign countries were doing along tha line and in the technology because at the Technical Information Center in Oak Ridge, Tennessee, we have a data base there that essentially gives us most research both domestic and foreign along those technological lines.

We were requested by the Joint Committee, I think, because of a request from the White House to tell us what our energy options were at that time, to present testimony to the Joint Committee on Atomic Energy about where we stood relative to the nuclear options that are most feasible in a short-range period of time. The Joint Committee then decided, looking at those options, which ones they would go with, and whether or not they would concur with the White House, that is, which one we should put the money in. The money was a big problem. Should we put money in all of these others and carry all five of them along, all four of them along, at the same time? Then they had to look at the possibility of getting that funding through the House and Senate Appropriations Committee. They decided that the one where they had the most expertise, the greatest advantage, was the Liquid Metal Fast Breeder.

One of the reasons happened to have been because the very first atomic reactor in the United States that produced electricity was a breeder reactor. It is known as Experimental Breeder Reactor #1 at Idaho Falls, and from there to

Experimental Breeder #2, and from there we went to the Fermi Breeder. So, they selected to support and fund the Liquid Metal Fast Breeder. We had other breeder technologies at that time like general atomics coming along looking at the high temperature gas cooler and looking at the gas breeders.

We at AEC, because of college demonstration programs that I started way back in 1961 on approval of appropriations, funded a little bit of money on that new technology too. Not alot; primarily it was done by industry. The breeder experiments at Oak Ridge were every year cut back, cut back, so it almost got to zero. Here recently, in the last fiscal year, Senator Baker from Tennessee decided to revive that and try to get some funding for it, to the tune of about $600,000 I believe or some low figure; you get the idea. And they are now gearing the Argonne National Laboratory to go back with some more of those similar breeder reactor experiments. But, essentially, that is the way the Liquid Metal Fast Breeder got to be the one. It required us to put in less money, and less time to make it to get to a demonstration phase for commercial feasibility.

DELEGATE: Let's say future decisions have to be made in certain areas and we as individuals would want to influence that decision. Would it be best to try to influence the Congressmen on the Joint Committee on Atomic Energy? Would that be the best place to go?

JENKINS: That is a way to go. I don't know if that is the best one. You have to realize that the members of the Joint Committee, once they take off that hat, they are your local Congressmen or your local Senators. That's why I sort of hesitate on that. It may or may not be the best way to go. It is, however, one way to go.

DELEGATE: What would be the alternatives?

JENKINS: The alternatives are that guy's office up in your hometown area, or your district.

HALL: One thing that is often missed is that a committee is not necessarily the component of that program. They are to be the reviewers of it. Now, there is certainly inhuman events once they have spent months looking at a problem and feel they have solved it that will be components of their choices. So, timing within the Joint Committee is important. As they are reviewing the problem, it might be helpful to consider them. But when it goes to the full floor, I think you've got to remember that they are numerically 12 out of 435 in the House or the same number out of 100 in the Senate.

HUNT: If you really care, and you are watching these hearings, and hearing dates are published, and your local newspaper may very well, at least the New York Times and the Washington Post is available, print what is upcoming as far as hearings. You can submit testimony when hearings are announced.

HALL: You could do it one of two ways. You could send directly to the Committee requesting something on the order that, I wish this to be included in the hearing records, or, depending on your relationship with your Congressman, you could send it to him asking him to bring it over. Now, the second one would have some value when it involves him. He's aware of what you are doing. Probably you would have the good sense to send him a copy. In either case, it would get in the records.

FRADIN: Let me describe what we went through, Tom Brownell and I, when we testified before one of those Subcommittees on Man and Space Flight on two occasions in 1972 and 1973. The way that developed initially just for your own experiences, I wrote to Congressman Teague asking to testify and as Tom (Hunt) mentioned earlier. They get such a large volume of mail, he never saw it or it never got through the process. Then one of the companies that supports us, the LTV Corporation, indicated that their Washington Contact, the Vice President Ted Mann, knows Congressman Teague very well; he's from the same district. So, he wrote to Congressman Teague on our behalf. Congressman Teague responded and invited us to testify. We then wrote again the following year, and we appeared again to testify on the Space Shuttle. At that point in time, we said that the next time we testify before the Subcommittee we are going to come here with the consensus of what the young people across the nation feel toward future space programs.

About the same time, we made a proposal to NASA to obtain support for FASST's development of an Aerospace Youth Council. NASA has yet to respond to that proposal. A year later, we made a similar proposal with the exact same words to the Atomic Energy Commission. They responded and now we came to this point in this meeting.

Last week we sent a letter out to members of the Aerospace Youth Council asking them to comment on the three hearings that Senator Moss is holding. One on Earth Applications Technology as setting up an administrative agency; the second one on Applied Technology Satellite #7 as a follow-up on the ATS6 which is now in orbit; and the third was on Advanced Aeronautics Hearings. Because of the short time to set it up with the staffers over in the Senate Committee, which would be Kirk's Counterpart, to receive the input directly in terms of letters, they sent copies to me.

What Tom (Brownell) and I are doing; if you come up with something substantial in terms of new fresh good ideas, we'll put together a statement on behalf of members of the Aerospace Youth Council and submit it to the Committee on Science and Astronautics and they may or may not decide to include it in the hearing. It is up to them. In some cases, they may even call upon us to testify on your behalf so the procedure that we would go through is we would have to poll the membership to get all of their input. As an answer to Laura's question for it, you do a report or something like that. FASST National Office's role will be to take a look at it and perhaps provide input to the group working on it. Then we must poll the respective sample of the membership, such that it comes out as a consensus of what the students and member think.

DELEGATE: Well, I can always submit testimony as an individual.

FRADIN: Right. The other thing is as individuals, not as FASST members.

DELEGATE: It could be more expedient in that it is going to be hard to get everybody's consensus when it's all done because the first hearing starts next week, and they only go until October, and then everybody starts school, etc.

FRADIN: I was referring to testimony on a certain bill that is before Congress. That is slightly different from Project Independence. Maybe you people on the panel can answer--if FASST came forward, or the Energy Youth Council came forward with certain kinds of testimony, it would carry much more weight than if just one individual sent something in. Am I correct?

HALL: Yes, in a practical sense because you often have limitations in the number of people you can troop by in one day and get to a hearing before Congress. They have other things to do, so that you'll find that for maybe one-half hour you've got four or five of them. The rest of the time you have one sitting and trying to be nice. You get too many people. So, secondarily, sometimes you have to make the selections that get the point you want to get across, and sometimes the point someone is making is not applicable to those. They are applicable to a total program, but not applicable to a time period.

DELEGATE: O.K. My experience with some hearings and what I have been told by some Congressmen is that they will take comments by an organization, and also by other citizens independent of that organization.

Before I came here, I participated in Army Corps. of Engineers hearings. I had five or six people from the same organization with me. Instead of having each of us get up for the organization that we represent at home, we stated one official organizational opinion, and the rest of us, expressed views as citizens, which also got into the record. You may not get to voice it there at the hearing, but it sure should go into the testimony and the official record as an individual.

HUNT: I want to speak to the practical side for a second. I think that in appearing before a hearing you convince virtually no one. I think you are better one-on-one with your Congressman. I think that is the strongest thing that you can do. I'm sorry, but you can agree or disagree, but you know it's like he says: Sometimes you are winding up with the Chairman sitting there, and we are getting into the record and that is the function; we want the record.

DELEGATE: Hearings look good because you have stated your position and get better results. Like Tom said, you can get one-on-one with a Congressman, and you can get a lot more done; although you won't get as well-known publicly.

HUNT: Not so with these FEA hearings.

JENKINS: I think that the FEA hearings are the best thing that could happen.

HALL: It is much different. I have testified as an individual on a number of Wilderness hearings in the West, and that was for a specific purpose. The FEA is an open-ended thing saying look, we need some help; give us some ideas. We as a country need some help. Therefore, they are soliciting. It is much different than having to solicit because the law says you have to. They are soliciting because they want to or they feel that it is necessary; I say "we" because I think it more than just a "they". It is not an outside organization. It is really a question that they are asking for some advice on.

JENKINS: I suspect that they will get a lot of people testifying. I'd like to say, by this example, that when we were asked by the White House to do the December 1st report, it mentioned that we were preparing a report looking at the nation's energy future within the limits of $50 billion to be spent in the next five years. Everyone who saw that announcement in the paper assumed that AEC had the money. As a result of that, we got 1200 proposals for spending that money. We didn't have it. We were just sending it out at the President's request. Now in light of that, just think what it's going to be like out there in those hearings around the country when they hold them. I imagine a large portion of those 1200 will be there plus a multiplication of those.

FRADIN: That is where the FASST National Office can help you out, that is, to make sure that whatever you come up with gets into the hands of the right person.

DELEGATE: How far can we go in lobbying?

FRADIN: According to the Internal Revenue Service, which has a very vague understanding, FASST cannot lobby in the sense of spending more than a substantial amount of its funds on any activity that affects legislation. There is nothing in going up there and telling what you think and there is nothing wrong at all with you going back and talking to your Congressman, but if we have to spend, and some people say there is a tightrope that you have to walk down on, I think that for the sake of understanding, I will have to make that final decision in terms of what the National Office will do in terms of expenditures, and whether or not we keep or lose that exemption. But there's a lot of leeway in there, and you guys are probably familiar with the difference of technical and professional societies in arguing this point for years--whether or not we should have a Washington Representative and go talk to Congressmen.

HALL: There is one other different role that one can play and that is providing information upon request. Once you get known as having some skills, people will start to turn to your National Office, and they in turn can turn to individuals. I know there are a number of professional societies who will do that, and they like to respond quickly with their members. So, that is a time sequence of building up a skill and a name which isn't going to occur tonight or tomorrow.

DELEGATE: You indicated that we should, before writing to a Congressman, be sure that it's in the right form. What exactly do you mean by that?

HALL: Well, you don't start off by saying I wish I never voted for you. I think you want to stay away from any sort of political overtones implied that if he doesn't follow this or that he is a stupid idiot.

FRADIN: Let me explain that in two ways. One, we can help advise you on how to phrase it. If you want us to take a quick look at it and give you a phone call for comments we would be glad to do that. We have been through this for the last couple of years. Second, if we ever get into our talking papers, there are two or three sheets in there that talk about how to organize your message in general and we would go into specifics on how you do it for Congressmen and that kind of thing. It is a very key question. We get letters, for example, one of our chapter presidents writes small, and it's just about impossible to read his writing, and he complains over and over again that we never respond to his messages. It would take us weeks to uncode the thing. And the format: the Congressman gets a report from you and there is nothing but one page after another of block types, no paragraphs, nothing. The chances of him reading it are very poor. So, the format in the way of the appearance of things is very, very important.

DELEGATE: About the FASST organization--If we are writing to Congressmen or we are talking to Congressmen, do you think that it would be advantageous to use the FASST name. I'm not talking about specific legislation. I'm just talking about going up and talking to your Congressman and saying I'm around and willing to help if there is anything that I can do. Do you see that as something that FASST should be following in this?

HALL: I think that would be a case by case basis. It would be hard to say. I think you might want to seek the advice of your National Office. I can see one case, for example, if it's a college unit within that Congressman's district. It would be good for him to know that he has more than just you but a whole body of people that could help on some piece of information. I would think that you would want to get away from implying that you are a political threat.

FRADIN: Maybe I could answer the question in this manner. A lot of times I think a lot of you try to get information for your SOS project. Sometimes you have not been able to get it. We find sometimes that FASST is known by a lot of organizations, and we do send a letter in asking for information. If you send it in on FASST stationery, you usually get a better response, so long as they have heard of FASST. That has become very helpful in obtaining information.

JENKINS: I was thinking along the line that if you make that kind of approach as an organization or a group, look at what kind of things that guy is dealing with that you can add input to. We get letters from people that say, "Well, I have got 50 acres of land and if the Atomic Energy Commission wants to use it to build a reactor, you are welcome to it, and I am standing by to help you in any way I can." Nice letter. Give us a smile, that's about the extent of it. But know what the guy is working on, and know how you can assist in that area, and offer your services that way.

FRADIN: One of the things we have done to facilitate that is that we bought stationery for each of the directors of the Energy Youth Council in envelopes and all you do is put "reply to" at the top.

DELEGATE: What do you all see that FASST has? What direction do you think an organization like this one should go?

JENKINS: Let me put my foot in my mouth. I have been sort of watching the political scene in areas, not around Washington, and the question came into my mind: how important is it to know the use of ideas, especially on a level of where you are now? Well, in my opinion, it is very important. You look at elections like Senator Fulbright, for example. Most recently in the State of South Carolina, look at the age differences between those who are now being elected and those who are not. And it tells me that in many cases where there are the incumbents who have been there 15 and 20 years, obviously the people thought it out more, they are still voting for him. But you've got an age difference. So now it is sort of shifting because the population is becoming aware of the political scene, voting for the guy who appeals to them with the younger ideas. Now once the guy is elected, he is going to really need the support of the electorate. If you are talking about what impact you think an organization like FASST would have, remember most of you in here right now are approaching the voting age, an age that you can express something through your vote. In that way, the guy who is running for office realizes you are meaningful in your approach. I don't really feel that he could ignore that fact.

HUNT: I'd like to go back again to the grassroots thing. I think that's where it's at, and I know John Burnett can go on a long time about it. But I really believe that I would like to see FASST expand its chapters across the country at colleges and universities with fairly strong chapters. Where you see people fighting the battles on the local front, dive in and say, "Here's my hand." If you think they are doing something wrong that's going to be detrimental, be persuasive in that fashion: offer alternatives. I'd like to see it spread in that fashion. I'd like to see it become a social action group, if you will, rather than burrying yourselves in technology projects. I like technology too. I like R & D, but as far as the degree of involvement, I think that's where it's at because a lot of things are going to happen at the Federal level. Your impact there is a ripple. Your impact at home across the country could be mighty and together that impact could be big.

HALL: One of the things that I see in FASST is my own job. So, I will extend a personal prejudice that I would like to see FASST have a role in. I think I came to Washington, D. C., as a person who was an advocate and very upset at people who weren't advocates of my position. But, my job is to make sure that a Congressman is well educated when he chooses to vote. He may vote the way I dislike. I guess to put it in a rather simple sense: if the world decided to pave itself over with concrete, I would hate that decision, but if they were aware of what they were doing and chose to do it in an educated manner, you can't argue with it. I would think it would be your purpose to provide information that you make sure that that person is making policy decisions in educated ways on both sides of the issue. Then you have a scheme as to next time whether you think you should be around. But don't ignore him because on that issue the choice was against you. I think that if you did that, you would defeat your own purpose. Continue to provide good information, even to people who appear to be an opponent, because sometimes you may start a point of view and cause some change on some issue.

A lot of these guys agonize at having to weight things as to importance. Those things I don't have to weigh in my position. I guess my point of view is important in order to provide the information and get your prejudices and points of view out in the open. That is one way in which you can be very helpful. If a lobbyist comes in to see a Congressman and he is openly identified with a company, that doesn't mean that he can't give that Congressman good information. Sometimes it helps the Congressman to have an idea of what that person's point of view is.

HUNT: Lobbyist is no longer a dirty word in Washington. A good lobbyist is counted on by these people and someone who can give good accurate information becomes someone who changes from walking through the door to try to persuade the Congressman or Senator of something to someone who sits in his office and the Congressman calls him and says, "Hey, John and so on.".The guy who says, You may not agree with where his company is on a certain issue;" but who says, "Here are the sides and if you want the other side of it, go talk to so and so." That guy is going to get through that Congressman's door and make an impact. So when it comes to something that he really wants, he's going to have an ear.

DELEGATE: The reason I am so firmly entrenched in the idea that we should first be a statewide organization is because different regions move at difference paces and different areas are ready for ideas that other areas aren't even willing to begin considering. Some areas of this country aren't as far ahead as other areas in environmental concerns, energy concerns, and a number of other areas. They have different kinds of problems and there are different things pressing of importance to different people. I was really surprised when I got back here and asked a number of people about their nitrification problem in the Tennessee Valley Authority. They never heard of it. They don't even know what it is. This is a serious problem where I come from because it is killing fish hand over fist. It is a problem and who knows what the answer may be? It's not important to people in the TVA because they don't have it, but it is very important to people in another region because they do have it. We can't get together on a national level and work on it on a national level until we are nationally caught up and reasonably even. And that isn't likely to occur for awhile, so we have to go back home and work at home, and we have to work in our states to do work on the problems that are most pressing there. That means working with state senators, state representatives in the state houses, in the state congress, because they have just as much power as the Federal Government, if not more. All they've got to do is flex a little muscle. You would be surprised at what they can do.

JENKINS: I was talking to Tom (Brownell) a day earilier, or Dave (Fradin) I guess it was, and I was mentioning my experience. I went to Washington, D. C. from Oak Ridge, and while I was sitting here in a field office, I guess I was sort of like Kirk was, I didn't advocate the decisions that political appointees that head up the Atomic Energy Commission were making on us. They don't really know what is going on. I just assumed that they say, "Well, today let's take up this policy...Stamp...Ready to go...Next!"

My job, of course, is similar to Kirk's and what Tom's was. You advise your boss. You do your staff work. Talk to staff and you get off the best opinion you can and you tell them what you can do to the Atomic Energy Act, and you sit down and try to lay it out for them, and you walk out feeling good, thinking: "I really had an impact on that decision!" Get in there, talk about it, and make a decision.

To my surprise, it takes six hours sometimes to make a decision, and the Commission, as it is set up, takes three of the five hours in order for policies to become in effect. I had previously assumed that everybody agreed, and they just stamp it and turn it out. But there are arguments on both sides that go on right there in that meeting. One thing they do is sit and sit and sit. Finally, they come up with three votes. When that is carried over to the Joint Committee, I am certain that they look at it from the standpoint of being on the Joint Committee, and being Congressmen and being Senators. It is an agonizing process.

My whole point is that on the Federal level where decisions are made, it is not necessarily true that all points of view are not taken into account, because they are. It is a very hard decision in 90% of the cases. It is very hard to come through with the decision on what should be done because of the divergent views that must be ironed out when you give each one of them a close look and find out what its merits are in total.

HALL: I would say that more often, in my own personal experience, the point of view is not heard because it was not spoken, rather than because it was stopped at a gate somewhere. I have had people call up the day before a bill was to go through and say, "There is this important bill. I've got to get an opinion in to you." I had it happen last week. A guy gave me an hour's worth of reasons, but he was two weeks too late, and he'll probably go back and tell somebody that Congress didn't listen to him. I couldn't. Nobody could have. He was too late.

FRADIN: One of the reasons we formed FASST's Legislative Advisory Committee was to keep us up-to-date, in addition to reading the Congressional Record, on what is going on in Congress. We wanted to publish a column in FASST NEWS called "Legislative News," but we never had the time, the money, or the staff to spend on covering that kind of subject. Maybe one of you might want to get the Congressional Record at home and write a column or parts of it for FASST NEWS. That way everybody else in the country can read about it and know what's going on.

DELEGATE: That can be a very extensive thing to do, that is, to have somebody up on it. It is almost like hiring a separate staff member to do that all the time. I think what some organizations say is that you pay an extra ten dollars to get that service, plus a membership fee. There are going to be people who are not going to want to receive that and it's going to be a waste of money for them to get it. However, it could be done not just in a newsletter. I think that would be something separate in itself. It could be typed up on stationery and xeroxed and sent off to people who are on the list who say they want that information.

FRADIN: We could very easily do that, but it becomes a very expensive process.

DELEGATE: Right. You would decide whether or not you thought it was important to put it in the budget.

DELEGATE: You have been talking a lot about input through government, and it seems to me that if we are meeting with a large group that we can have a lot of effect on our local level as do other lobbying groups, like the Sierra Club, the League of Women Voters, etc. We can present the types of things that we arrived at here and convince them and make them carry on and set up that kind of change. They've got a big membership, and they'll carry on our views and so on. They've got a lot of input at different places that we don't have access to.

HUNT: I hope you discuss that tomorrow as well as at service clubs, your visibility in your own communities, and how you can really be an outreach person.

HALL: I think there you can provide an invaluable service. Let's say regardless of your point of view, you have a group like the Sierra Club which is quite opposed to nuclear reactors and are proposing solar energy as a solution. My point is that you can provide them technical information so that they are at least correct. It doesn't mean that you are necessarily trying to change their point of view, but there again, provide the information to them so they are factual. and correct, so they have to look at all the facts as well. In any case, even to people that are pro-nuclear, provide the facts to them also. You could really be a core to opposing view points, and by being such a core, you could bring some opposing viewpoints together. Sometimes arguments are from ignorance.

HUNT: I did want to make one point, that being, that there are two people here, John Coopersmith and Sylvia DiSanti who have spent time in Washington working in the Intern and Page Program. Federal agencies, and Congressmen and Senators have intern programs for summer work. Investigate that. I hope some of you are interested. It doesn't pay a whole lot, but you'll learn more in a short period of time than you ever thought possible and have a great deal of fun also.

HALL: Some of these programs are sponsored through universities.

HUNT: Right. Investigate your schools and see what they offer because it is a real education. There are a lot of kids back there doing the same thing, and you don't just sit there and answer letters either. You really get a full range of things to do, and some of them can be very important and educational.

DISCUSSION

PROJECT INDEPENDENCE

Donald L. Morris, Federal-State Liaison, Region IV
Federal Energy Administration

DELEGATE: Right now, on the Simulator (Energy-Environment Simulator) over there, it says that each individual uses about 80 man hours worth of energy per day. How is that proposed to change in the future in Project Independence?

MORRIS: Assuming strict adherence to strong conservation measures, the average individual would reduce his energy consumption by 15 to 20%. We have been increasing our energy consumption by about 5% a year as a nation and our supplies are obviously not keeping up with that demand. Therefore, we are trying to reduce the growth rate of energy demand to below 4% per year. Instead of 80 man hours worth of energy for each individual we would hope to lower this requirement to something under 70 hours.

DELEGATE: Do you want to cut the actual use, or the rate of increase of use?

MORRIS: First, we hope to cut the increase in energy use. This will only be possible through implementing greater efficiencies in the way we use our energy. For example, by reducing speeds on our highways we not only save fuel but save lives. Also, we must lower our thermostats to 68 degrees Fahrenheit or below in the winter and raise air conditioning thermostats to at least 80 degrees Fahrenheit. Our automobile engines must be modified to attain greater fuel efficiency. We can also conserve energy by installing adequate insulation, weather stripping, storm doors, and storm windows.

DELEGATE: Then the answer is to cut the actual use?

MORRIS: Right; through greater efficiencies.

DELEGATE: What is the procedure for getting on the agenda for Project Independence?

MORRIS: All you really need to do is submit one copy of your testimony and you will be allowed to speak at the hearings being held in your region. One copy would be sufficient.

DELEGATE: My question is on the United Nations. You mentioned the question of isolation, and I'm worried about the fact that you said we're trying to be independent. It's a whole world problem--we really haven't mentioned it too much in this conference. We haven't really gotten into the question of it being a world problem and how to solve this whole problem. I know that the United Nations has the U.N. Food and Agriculture Association looking into the food problem. I'm wondering if there is any effort being made on the part of the U.S., the Federal Energy Administration (FEA), to really go out and endorse some action on a worldwide basis; setting up agencies to administrate policy and start working with other governments on doing these things. I know there was a lot of talk about the Arab oil crisis, but I want to know what, as a world independent project or something, is being done?

MORRIS: First, the FEA was established to work with domestic energy problems only. As of now, we have not been involved in international energy problems.

However, just as there is an organization of oil producing countries, there is also an organization of oil consuming countries, and we are trying to work out solutions to shortages and attempt to help each other in times of crisis.

JENKINS (Atomic Energy Commission): Part of that priority is under Secretary of State Kissinger. Last February, there was a Washington Energy Conference. As a result of the Washington Energy Conference, a group was formed that is known as the Energy Research and Development Group. Also, the Chairman of the Atomic Energy Commission will appoint the head of the Uranium Enrichment Coordinating Group, ad hoc. Last May 1 through May 10, we did go to Europe. We met first with a group in Brussels and that meeting lasted for two days. They are also continuing to meet, I might add. From there we went to Germany, from Germany to Sweden, from Sweden to England, from England to Paris, and then back to the United States. At each stop, we dealt with those people who were in the category of being the Ministry of Energy for that particular nation.

In the middle of June, we also met with some members of the Energy Research and Development Group in London, England. There is a concerted effort to coordinate. These people were primarily of the energy-using group rather than from the energy-producing group. But yes, there is a coordinating group of sorts looking at the total world energy supply and how this is coordinated.

DELEGATE: I would like to pursue the question that was brought up of the teleological basis of the idea of Project Independence, and whether you think that the methodology and choice of the future in dealing with politically unstable, or just politically "uppety" nations insofar as energy, is going to be the same sort of thing with regard to other resources. For example, if the copper producing nations form a strong cartel and then try to exert demands for price increases on the U.S., will we see similar programs of independence for other sorts of minerals or resources or other necessary materials similar to that of energy?

MORRIS: Well, it is highly possible that other natural resources could be embargoed just the same as oil. International cartels/collusions have been attempted in copper, coffee, etc., before. They have worked only a short while. The success of the oil embargo could lead to embargoes in other areas, such as, foods or natural resources. Therefore, it could become necessary to include other goods in our conservation efforts. We are hopeful that the cartel is going to break soon and that a repeat of the oil embargo does not occur. But, there is no assurance that it won't happen again.

DELEGATE: There are nations in the world, such as the coffee producing nations and the copper producing nations and so forth, that have seen that it is possible to get something by doing this. At this time, they are getting such things as nuclear capability because of what they did. Well, it may hurt them a little bit now, but the realization that we can be hurt is evident. They brought us to a standstill. Other nations are going to look at that. So how is this Project Independence supposed to alleviate that problem?

MORRIS: Well, hopefully, by the things that were mentioned here which we are planning to do and by the efforts we are talking about coming up in the hearings. We don't have the answers to that right now, but hopefully, from you and the people in the U.S. will come these answers so that we can make the decisions. We aren't involved in anything except energy. Obviously, we don't get involved in coffee beans, copper or other things.

Yes, they could well do the same thing, but my point is that historically they have never helped. They are very short-termed. You saw coffee prices go up back in the 50's two or three times what they normally were. But suddenly Brazil broke (or whoever it way; I think it was Brazil). They were the biggest producers, and they said hell, we're going back to the free market price. So, hopefully, this will happen. We have no assurance that Project Independence would certainly keep this from happening because we cannot control what goes on outside our borders that much. We can work with the diplomats of other countries, and we can try to assure that this embargo-type situation will not occur again. But there is no assurance.

RIGSBEE (Phillips Oil Company Representative): If Project Independence is successful, we will become less dependent on these Arab nations or the petroleum controlling countries. Then that in itself would be a deterrent to any other cartel that might say let's get the benefits that we can get. The benefits they get will be short-termed, because the long-range benefits may be disasterous to what they are trying to accomplish.

MORRIS: Let me just take one more question.

DELEGATE: I would like to know a fact of continuity of Project Independence from one part of the administration to another. I'm afraid that during one administration there might be a big push for uranium breeder reactors, while in another administration there might be a complete turnaround from uranium to plutonium reactors.

MORRIS: Yes, I think the problems you mention, political problems, are the same though, because the FEA was established officially on June 27, 1974 by the Congress, not by the President. The President set up the Federal Energy Office (FEO) which was a temporary executive agency, but the permanent agency, the FEA, is no different from any other agency in that it will continue so long as the Congress desires. The President can't say, "I'm just going to cut it out"--he could have up until June 27. Regardless of which administration is in power the final decision will be balanced by the five areas that we have mentioned: the political, yes, but also the economic, the social, the technical and the environmental. So, they are all going to have a power and an input in each decision and the final decision will be the power, or the lack of it, for our future in energy. Thank you very much again for inviting me; I enjoyed it.

ENERGY CONSERVATION
"A Federal View"

Dr. Douglas C. Bauer, Director of Research Planning and Systems Studies
Conservation and Environment, Federal Energy Administration

It is a pleasure for me to have the opportunity to join with you in this National Energy Youth Conference dedicated to the critical and all pervasive energy problem. Indeed, as your conference theme suggests, this problem does constitute a problem for tomorrow's leaders. I might add that it also provides ample homework for today's leaders, as well.

You have chosen a very appropriate location for your conference. For years, leadership in energy activities has been developed and has made its mark from sons and daughters who have travelled this way in their careers. It has been my distinct privilege to work over this past year with one of Tennessee's most distinguished sons, Dr. Jack Gibbons, who has left his mark on the course of national energy activity and has set us on a course in energy conservation which is correct for the nation and for the times.

And what kind of time is this? It is a time for testing; a time in which we all face the challenge embodied in the first objective of the FASST Energy Youth Conference: to enhance (our) understanding of the social, political, environmental, technical and economic aspects of the energy problem. It is a time when each of us personally, who would contribute to the resolution of the energy problem, must dare to venture out from under the security blanket of our separate, discreet, academic disciplines and havens, and take on a goliath that does not permit us the luxury of solving the same old set of equations with slightly altered coefficients and units.

Several evenings ago, Mike Wallace at large, reviewed a new book entering on the scene entitled The Best. In this book some enduring quotations by public figures were sited as valid hallmark for enduring conduct. One such quotation was that of a Roosevelt, namely Alice Roosevelt Longworth. She is quoted as having said: "One should strive in life to fill the glasses that are empty and empty the glasses that are full."

I find that counsel particularly fitting for the energy problem as we seek to define a balance between enhancing supplies (filling certain glasses) and managing reductions in our rate of demand growth (emptying certain glasses). Our energy resource problem is conspicuously a problem in which certain fuels are very scarce and too many users (who really have alternatives) are drinking deep of a cup which too soon, left unchecked, will empty important glasses. On the other hand, other resources, like our abundant coal supply, fill one of our energy cups and should be glasses which we encourage our industries to start to empty.

The point I am trying to make is that "Balance" is a critical descriptor of the activity we must be about. We must balance the needs in our economy for sensible growth, general employment, and rising lifestyle more evenly accessible by all our citizens with deliberate efforts to reduce wastages of specific, precious energy resources. We should promote certain kinds of growth and discourage others. We should exploit certain resources at accepted environmental cost, passed on as best as can be done to the consumers of those resources. We should preserve certain kinds of environmental quality and pass on the costs of resources foregone in that option to the consumers who benefit from that environmental preservation. These are difficult assessments to make in each instance in which they arise. We are comparing apples and oranges; we are, in the language of the economists, simultaneously weighing internalized and non-internalized "costs."

But while the complexity of these trade-offs, to use an over-tauted word, causes us to pull our hair out; while we do not enjoy the assurance of the mathematician that there exist "unique" solutions to the energy problem; while we are continuously dealing, again in the mathematician's language, with an "under-constrained" situation, we enjoy the opportunity, for awhile if and only if we act now, to make choices. The ultimate shape of our national energy policy will not eminate from some slick optimization model on a computer, but from political choices arrived at in the forums of free institutions at all levels in a democratic society.

In the time I have this morning, I would like to discuss the importance of energy conservation in the energy balance we are drawing. It is a vital ingredient of Project Independence, the blueprint by which we are attempting to achieve an improved degree of self-sufficiency of energy resources. It is the single most important contributor in effecting a balance between supply and demand in the time frame before 1980. Sensible energy conservation measures, i.e. energy conservation actions which are cost-effective to the user or institution, which must accomplish substitution of new technology for lesser efficient technology, or materials or labor for energy, or time for energy, can achieve savings of 8 million barrels per day of oil equivalent by 1980 (17 percent of unconstrained demand) and 13 million barrels of oil per day equivalent by 1985 (23 percent of unconstrained demand). No single domestic supply option or combination of purely domestic supply options offers us the promise of this kind of effect in these same time periods.

Now why is it important for us to go after these sensible energy savings? The following facts fairly represent the motivation for the effort:

(1) For the past twenty years, U.S. demand for energy has grown at a rate of 4 to 5 percent per year;

(2) Today, U.S. per capita use of energy is six times the average for the rest of the world;

(3) U.S. crude oil production leveled off in 1970;

(4) U.S. coal production has not increased appreciably since 1943;

(5) Since 1968, we have been consuming natural gas faster than we discover it; and

(6) Imports have increased from 15 percent of our oil supply in 1960 to 30 percent in 1972. If nothing is done, about 50 percent of our oil supply in 1985 could come from foreign sources.

The crux of our "energy problem" is a gross mismatch between the kinds of energy that constitute our recoverable reserves and the kinds of fuels we presently use to meet our demands. In terms of recoverable reserves in the U.S., about 94.5 percent on a BTU basis is in the form of coal; the rest is divided evenly between petroleum and natural gas. But 46 percent of our consumption is in petroleum; 31 percent in natural gas; one percent nuclear, only 18 percent coal, and the rest hydropower.

You undoubtedly appreciate at this point from the excellent displays that were provided to you by Shell and others before this conference that the broad uses to which our energy is dedicated are as follows:

43% to industrial applications
24% to transportation
19% to residential use
14% to commercial use

Viewing the industrial, residential, and commercial use in more disaggregated terms, I want to draw out for emphasis how important heating processes are. Space heating consumes 17.7 percent of our total energy consumption. Process steam usage constitutes another 16.4 percent. Direct heating uses another 11.0 percent. Now, as I mentioned, transportation accounts for about 25 percent. All other applications of energy individually account, that is each separate one, for less than 10 percent. Thus, you can appreciate the emphasis on technical research for conservation in the area of combustion processes. I'm reminded of an admonition that my nuclear engineering professor at Cornell gave us years ago in criticizing a comment in a nuclear engineering text book that "Nuclear reactors should not be considered as mysterious. We understand them almost as well as we understand the internal combustion engine." Mark Nelkin observed, quite properly, I believe, that we understand nuclear processes quite a bit better than we understand combustion.

Slide 1 disaggregates energy end use in transportation and highlights the critical importance associated with striving to find ways to use the highway system more efficiently. A finer disaggregation of transportation demand taking into account trip purpose is presented in Slide 2. The Federal R&D budgets reflect the intense interest in stimulating more efficient automobile development as well as highway system development. I shall comment in more detail on that budget later.

Now, so far, I have dealt in rather static terms, describing energy consumption patterns about as they are today. What I have not described is the dynamic trends in these energy patterns which are as important for our consideration as how we today use our energy resources. Specifically, I would like to discuss some of the kinds of energy growth that make up the "4 percent per year" average growth rate I previously mentioned.

The rate of growth of our energy demand has been astronomical. Since 1950, it has increased 123 percent as follows:

- Industrial - an 84 percent increase;
- Electricity - a 285 percent increase (about 6 percent per year; doubling every decade);
- Commercial - a 141 percent increase;
- Residential - a 116 percent increase;
- Automobiles - a 214 percent increase; and
- Public transportation - a 53 percent increase.

Slide 3 presents the total growth and growth by transportation mode projected in the future. Of concern is BOTH the rate of increase and total resource requirement implied by this increasing demand and the enormous increase projected for the air mode, the most energy-intensive way to move people. It suggests one of the underlying concerns in the discussions currently underway in resolving modal balances and managing future growth.

Transportation, which uses about 55 percent of our petroleum, has evolved over the past twenty years into ever more energy intensive activity. The next Slide 4, summarizes trends in energy intensity for passenger modes. We find ourselves today with 98 million cars consuming 75 billion gallons of gasoline traveling over 1000 billion miles each year; 6 percent of our land is covered with asphalt sinews and the efficiency of each year's cars is declining (for all kinds of reasons, only one of which is environmental protection devices).

I hope that this background provides some basis for you to appreciate how important it was and is to maintain the 55 mph speed limits. Through that action we are saving about 200,000 BPD of gasoline. We also are saving a great many lives. National Highway Traffic Safety Administration figures several months ago indicated we are saving almost 25 percent of lives we otherwise would be losing (in comparision with previous years).

It should also help provide a framework to understand how important it is to stimulate both the development AND the acceptance by the consumer of more efficient cars.

The FEA is concentrating on three programs to reduce energy consumption in transportation: First, in cooperation with the automobile manufacturers, we shall soon be establishing specific, measureable auto efficiency targets for alternate years through 1985. Roger Sant, the Assistant Administrator for Conservation and Environment at FEA recently stated our goal (Phoenix, 6/28/74):

> "...to keep gasoline consumption level through 1985--total consumption no greater then, even with more cars on the road traveling more miles..."

As Mr. Sant points out, that goal can be accomplished only by strictly enforcing the present nationwide 55 miles per hour speed limits and increasing the miles per gallon of new cars. Meetings have begun with two of the automobile manufacturers, and this goal looks reasonable. That action would save 1 million barrels of oil per day by 1985.

The second major transportation program involves work cooperatively with the Environmental Protection Agency to ensure effective implementation of a voluntary auto efficiency labeling program and to prepare for implementation of a mandatory program later on.

Third, in cooperation with the Department of Transportation and the Interstate Commerce Commission, we are seeking to develop policies and programs to shift freight and passenger transportation from less efficient to more efficient modes. Per ton mile, trains are four times more energy efficient than trucks and 60 times more efficient than airplanes.

None of us is deluded that the process of altering the regulatory and incentive structure affecting our transportation system will be a "piece of cake." You have undoubtedly read in your newspapers of the defeat a couple of days ago of the $800 million operating and capital subsidy program in the house (for mass transit). It will not be easy, either, to change the patterns of federal investment in transportation development that between 1957 and 1970 saw the federal government spending some $66 billion for transportation, distributed as follows:

* 71 percent for highways (three-fourths from the Highway Trust Fund);
* 15 percent for airports, air carrier subsidies, and airways programs;
* 13 percent for inland waterways and harbor development (including Coast Guard expenditures and Corps of Engineers activity); and
* 1 percent on public transit (up to 2 percent recently).

Some important shifts in this pattern of subsidy have begun. They must continue. The DOT UTAP program is an important longer term evolution deserving our endorsement.

With the exception of the High Speed Rail program and some limited support to AMTRAK, there have been no capital or operating expenditures, federally supported on anything like the scale of federal subsidies to the highways, for the nation's intercity railroad system. Even though the capital requirements for railroad rolling stock modernization amount to $3.5 billion/year, investments have been only about $1.5 billion/year over the past 20 years. Is it any wonder that railroads are in the plight they are, despite the energy problem. The process to turn that kind of in-place "system" around is not an easy one and is not up to any single institution. I need not review for you the terribly difficult process DOT and the ICC have been going through, with the Congress, to try to identify a rational course for the Northeast Railroad system. With capital money so scarce, it is very unfortunate that such large chunks of it have had to be reserved for very large labor settlements.

Slide 5 presents a good quantitative summary of the likely energy savings from a broad range of transportation energy conservation approaches. It should be used only as a guide to get a handle on where the biggest savings potentials lie. It in no way comes to grips with the complex institutional, social, economic, political, and other problems associated with getting any of these potential savings to happen. For any one action to be accomplished requires the simultaneous consideration of issues across the board - the very same broad based considerations that this conference is addressing.

Now, at the request of Roger Guisinger, I have emphasized transportation energy conservation considerations; but, if you would permit me, I would like to present a somewhat broader context for you in the framework of the important Project Independence activity in which we are deeply engaged. Transportation, as I have mentioned, is terribly important in this work but is only one activity, one end-use sector, if you will. Equally important issues are involved in industry and buildings and in cross-cut work that does not fall neatly into any single end-use sector. So in the time remaining I should like to discuss Project Independence a little as a kind of introduction for you to keep in mind this fall as public hearings on the Blueprint are covered in the media in the ten separate cities in which these hearings will be held. I shall also highlight the general and specific policy issues that we are evaluating in demand reduction. These might be interesting topics for us to discuss in the question and answer session at the end of these remarks.

Obviously, the path to an improved degree of self-sufficiency involves enhancing supplies as well as dampening growth. For example, we have almost half the free world's known coal reserves. Enough to meet our total energy needs for centuries. But we have to solve serious environmental issues to get that coal into our supply stream in a form sufficiently flexible to meet our varied requirements. We also have to ensure we have the total infrastructure to support rapid escalation of coal production, including capital. We must push ahead with coal gasification and liquefaction technology development to ensure the versatility our multiple needs require.

We have the equivalent of 1.8 trillion barrels of oil locked up in our massive oil shale reserves in Colorado, Wyoming, and Utah - enough to last more than a century. To exploit it, we must press ahead with process R&D. We must also assure ourselves that secondary constraints, like water availability, are manageable.

Less than 3 percent of the outer continental shelf has been leased in the twenty odd years since the program was originated. We cannot permit that critical resource to lie underdeveloped any longer.

Recall that I observed only 1 percent of our energy demand is satisfied by nuclear power - about as much energy as we produce by burning wood. The development and utilization of nuclear power is a critical component of Project Independence. We must push ahead with the liquid metal and other advanced breeder programs given the realities of the availability of U-235 resources. It is appropriate that serious attention be devoted to ensuring that these plants are built and operated safely with acceptable environmental impact. But the process to determine that impact for each plant can be shortened from a decade to more like six or seven years.

Although, of course, we must continue to support development of longer term energy sources, e.g. fusion, geothermal, and solar energy, for the next decade these will remain in the research and development phase and cannot materially affect the energy supply situation until after 1990. After touring through a potential geothermal site at China Lake last week in California, I am most respectful of the difficult materials problems and site discovery problems that surround the practical exploitation of the geothermal source.

As far as the relative emphasis between supply enhancement and demand growth control, I feel that the appropriate litmus is to support projects which save a barrel of oil so long as the cost of that barrel saved is less than the cost of a new barrel of oil produced (through resource development).

Project Independence will demand a closer partnership with American industry. Recall they consume the biggest chunk of energy (43 percent). There's no way we can meet stiff energy conservation goals unless we obtain their cooperation both in the setting of the goals and in defining the process by which they can be obtained. Data must be shared and protected where genuine proprietary interests are involved.

It also will be essential for a new structure of international cooperation to be forged between producing and consuming nations and among the NATO allies (as through the Committee for the Challenges to Modern Society). In that process, we are going to have to identify more precisely the interests of the world energy suppliers as THEY survey the world scene - not just our own.

The Federal R&D budget for the current fiscal year, in relation to the year just ended, reflects features of our approach to the energy problem:

ENERGY R&D OBLIGATIONS
(Millions of $)

	FY74	FY75	% INCREASE
AEC	646.0	932.0	44
DOI	224.0	549.0	145
EPA	69.0	182.0	164
NSF	32.0	102.0	219
OTHER*	28.0	47.0	68
TOTAL	999.0	1,815.0	81

(*"Other" includes DOT, DOD, NASA)

Coal conversion technology received the largest percentage boost of any energy R&D program. It comprises over 50 percent of the DOI budget. The energy conservation R&D is largely imbedded in the DOI program and reflects $22.9 million in FY75 vs. about $5 million in FY74. The nuclear activity, of course, is located in the AEC budget.

The Project Independence activity involves the following functional activities:

International Assessments
- Estimates of import availability, reliability, price
- Emergency programs

Resource Development
- Producing unconstrained supply curves for oil, gas, coal, nuclear, oil shale, synthetics, solar, geothermal, energy facilities
- Providing requirements for scarce resources

Research & Development
- Identifying potential impact of R&D on supply and conservation
- Conceiving long range (beyond year 2000) energy strategies

Cross-cut Studies

- Analyzing resource constraints in water, manpower, materials, equipment, finance, transportation, and environment

Quantitative Analysis
- (Integration) producing consistent estimates of price and quantities of different fuels in different scenarios
- (Economic impact) macro-economic impact of scenarios and impact of embargo

Demand
- Project demand for various fuels
- Integrate effects of conservation measures

Conservation
- Effect of conservation policies on demand

Now what is all this organization setting out to do? Basically it is directing itself to conceiving a blueprint which it can deliver to the White House on November 1st. This blueprint will lay out the options, the costs and benefits for alternative approaches to achieving self-sufficiency. It will form the framework for our energy activity thereafter.

For just a minute, I would like to highlight the kinds of broad and specific policy issues being addressed as far as demand reduction is concerned:

Broad policy issues include:

1. What should be the extent of the government role in conservation? What are the effects that rising prices alone will accomplish? What direct actions are required?

2. What can we realistically expect from demand reduction to avoid overextending resource constraints?

3. What is the proper balance in all terms between demand reduction and resource development?

4. What are the social and economic impacts of conservation as well as the energy savings?

Specific policy issues include:

1. Improved truck, auto efficiency;

2. Residential/commercial heating, air conditioning, and lighting programs;

3. Incentives for adoption of model building codes;

4. Changes in utility rate structures, public utility reform, controls/strategies for electricity development, and demonstrations;

5. Extent of use of solar heating and cooling;

6. Policies for adjusting federal transportation policy;

7. Operating subsidies for mass transit;

8. Use of federal loans in HUD (FHA) to promote residential retrofit;

9. FHA appliance standards;

10. Capital investment incentives for industrial equipment; and

11. Incentives for improved energy waste management.

These kinds of issues along with similarly detailed issues on the supply enhancement side will be discussed in the public hearings scheduled for ten cities. These start in Denver on August 6th and end up in San Francisco on

October 7th. Incidentally, while energy conservation can be discussed in any of the cities, it will be featured in the San Francisco public hearing.

Now I recognize that this has been a very hasty overview of Project Independence insofar as it relates to energy conservation. I've merely tried to whet your appetites and would prefer discussing what you might wish to discuss in the question and answer session. At that time I would also be happy to discuss in more detail the kind of broad, inter-agency, inter-disciplinary R&D we are engaged in. I leave that to you to decide.

I believe that there are several important considerations regarding our energy future which we should keep in mind for the long haul. With these, I should like to conclude my formal remarks.

First, our most difficult public sector task in energy conservation will be to retain the attention and interest of Americans and all their private institutions in conserving energy. This is not some glitch we are going through. The energy problem is a chronic, long term affair.

Second, the kinds of major capital shifts that will be required to effect substitutions of time, labor, and materials for energy are going to stir the waters. They are cost-effective, but there are transitional problems that will cause some disturbance. We've got a lot of institutional development we are going to have to accomplish to see these through. For example, in transportation, STILL only 20 of some 254 major cities have central transportation organizations which can both plan and fund integrated transportation plans.

Third, the momenta in lifestyle, public subsidies, and the rate of exploitation of resources are well established in directions that will be difficult to alter. A number of people and institutions in powerful arrangements are benefitting from the current status quo. There will be a good deal of contention in altering that fabric. We're all going to have to learn along the way and ultimately accept some compromises. There are no panaceas out there. All the gains will be on the margin.

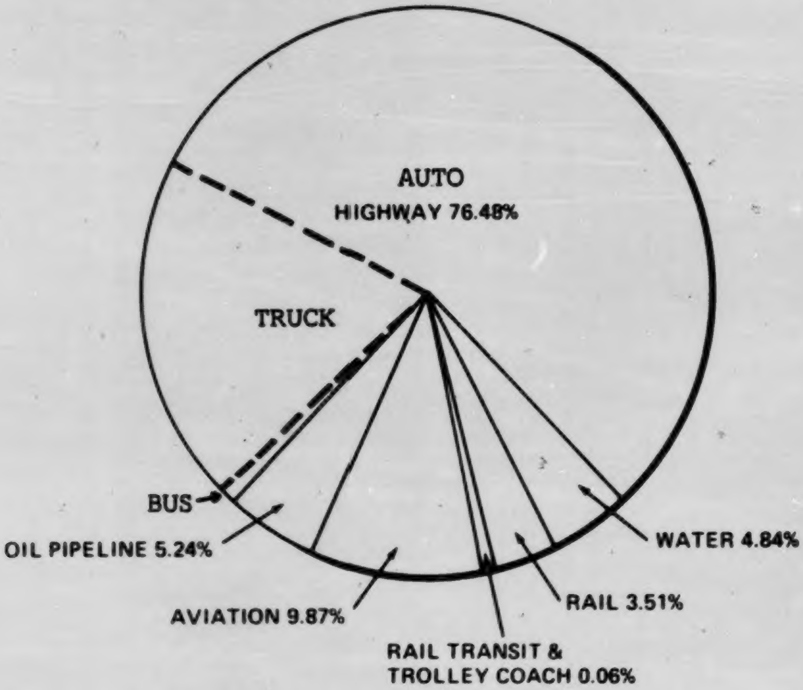
As with any great national problems, the energy problem poses opportunities as well as difficulties. We have the opportunity to arrange ourselves much more rationally with our natural environment. It's time we did that. It's time we assessed our lifestyles and determined individually and voluntarily as it is our privilege to do in a free society what quality of life and what pace of growth of what kinds we want. These are great issues which touch ultimately upon our values, not our technological expertise. We live in finite dimensions, not limitless ones. We have to consider all the costs of our future not just the financial ones, internalized in our economic system.

As young people you have in both these assessments and in their outcome critical roles to play. It's a great if difficult time to be alive. You can, but you must, choose the glasses to fill and the glasses to empty.

Thank you.

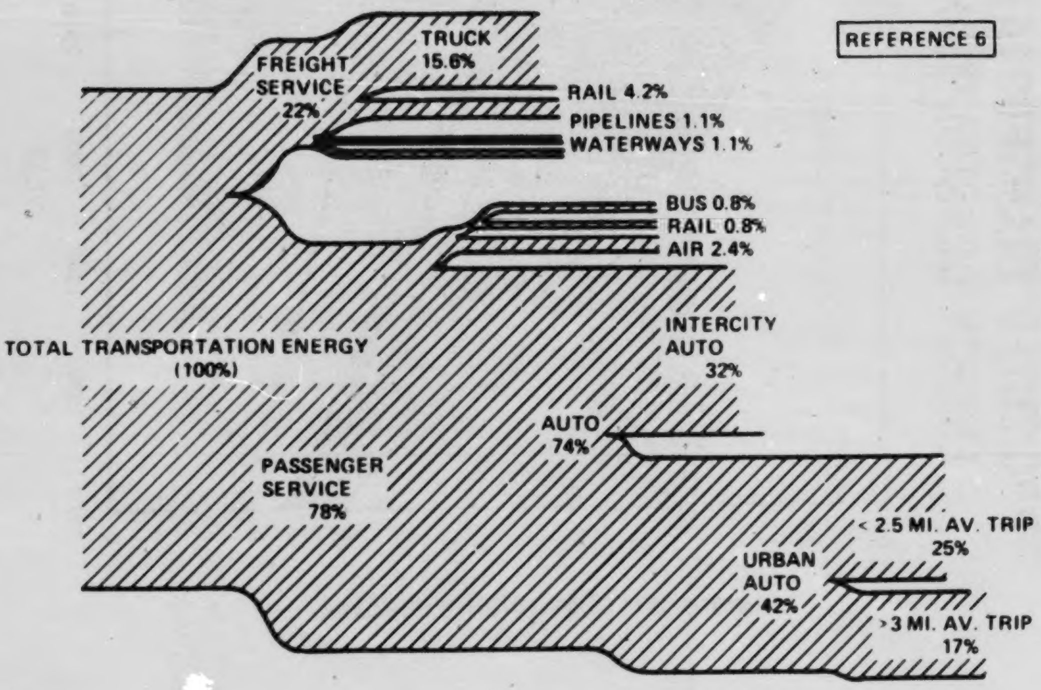
Slide 1

ENERGY CONSUMPTION - 1970 (BTU'S)



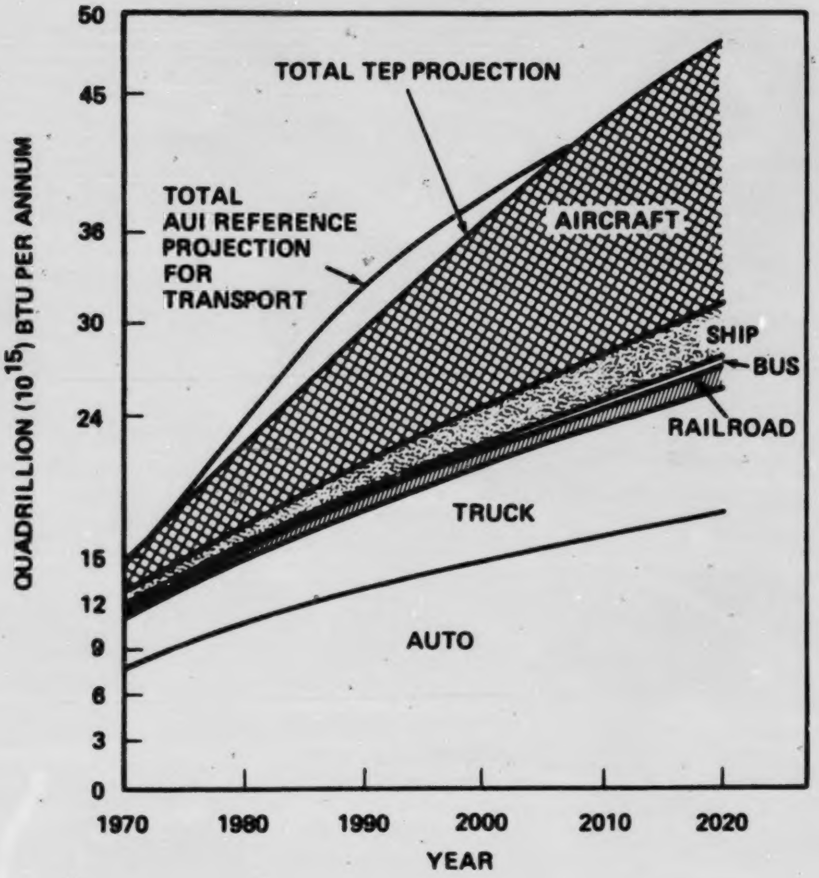
Slide 2

U.S. TRANSPORTATION ENERGY DISTRIBUTION BY MODE (MID 1960'S)



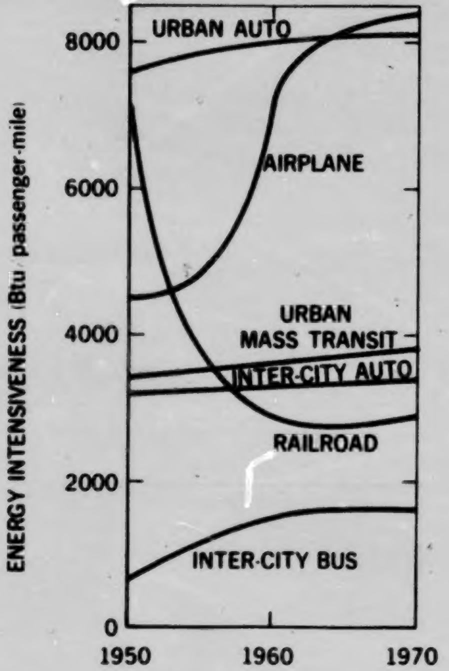
Slide 3

PROJECTED TRANSPORTATION ENERGY CONSUMPTION



Slide 4

HISTORICAL VARIATION IN ENERGY INTENSIVENESS FOR PASSENGER MODES



Slide 5

ESTIMATED ENERGY SAVINGS OF SELECTED POSSIBLE ACTIONS IN THE TRANSPORTATION SECTOR

	ACTION	SAVINGS (% OF TOTAL TRANSPORTATION ENERGY)
1.	INCREASE SMALL CAR SHARE FROM 7% TO 50% OF CAR POPULATION (22 MPG VS 13.6 MPG)	9.5
2.	REDUCE FUEL CONSUMPTION OF HALF HIGHWAY VEHICLE POPULATION BY 30%	12
3.	DOUBLE OCCUPANCY OF HALF URBAN COMMUTE CARS FROM 1.6 TO 3.2 VEHICLE MILE	7
4.	LIMIT TOP SPEEDS OF CARS AND TRUCKS TO 50 MPH	2-2 1/2
5.	REDUCE TRAFFIC CONGESTION	< 3
6.	SHIFT HALF OF CBD COMMUTERS TO PUBLIC TRANSIT	1.4
7.	WALK OR BICYCLE ALL ONE WAY TRIPS ≤ 2 MILES	2

QUESTION AND ANSWER SESSION

"Energy Conservation--A Federal View"

Speaker: Dr. Douglas C. Bauer

DELEGATE: How did you arrive at the savings for the various options, Dr. Bauer?

BAUER: These were calculated on the basis of "what if", and solely provide some hints about relative savings in order to focus policy. For instance, what if we improve half of the cars by this much, how much energy is involved? What's the purpose of that? The purpose of that is strictly to quality the relative savings. If you're going to undertake a massive implementation hassle, you want to have assurances of substantial savings to justify that effort.

If it turned out that we got all the people out of their cars into buses or mass transit systems and saved only one-tenth of one percent of energy, then the hassle wouldn't be justified because there's not enough payoff in terms of what's going to happen in energy to justify the enormously complex difficulty of getting it to happen. For example, I don't think there's enough buses or enough mass transit systems. However, people don't want to travel buses or by mass transit all the time so the only purpose of that is strictly to ask: Where are the big ticket items, as best can be seen?

The automobile is clearly a big ticket item. You don't want to bring in Ford and General Motors and Chrysler and hassle them about getting efficiency up at the same time they are being hassled about meeting environmental quality standards, especially if there is not any kind of fuel that is involved in that. If it's a Mickey Mouse thing, it's not going to really save a substantial amount of energy. However, the point is that it does. There's a lot of energy that's wrapped up in the trend toward lesser efficiency automobiles. There is an urgency in obtaining their cooperation in moving toward sensible goals that will still keep people employed, but move the efficiency upward, that's the important thing to be said. That's the only sense in which you can use that kind of analysis. Now, I've emphasized transportation pretty much here.

DELEGATE: I have some questions about "Project Independence", and I don't know how much there is covered in the paper that you brought with you, but exactly how long are the hearings going to last, and what is going to happen? Is there going to be a book written about what the hearings cover and what the answers are going to be, and will that be submitted to the President and will the President make recommendations to Congress? Exactly what's going to be the procedure after the hearings are completed?

BAUER: First of all, there are two parts to Project Independence. The first part is a set of early action items which says those things we can do when we sort out what exactly it is we want for the long haul, just to get the thing moving. It's proper that there be some concern about the safety and environmental impact of nuclear reactors, so we really ought to be able to resolve those issues in something like seven years, rather than a decade. It's clear that if you want to get coal then, you better have some equipment to get coal so you can expedite the process. There's a whole range of actions like that that are associated with just trying to get the system less sticky. That's early action.

The second major portion of Project Independence is the blue print; the creation of a blue print which says O.K., here's where we are today. We have a a range of alternatives that will move us in the direction of more self-sufficiency, and it shows the prices that will have to be paid in order to do that. That's a document that's to be prepared and to be delivered to the President on the first of November. It will be a set of choices that can be made. As part of the input to that document, there are a series of public hearings that are starting in Denver on August 6 through 9, 1974; and hearings are also scheduled in nine other large metropolitan cities across the United States.

For each of these ten cities, there's a major theme that's emphasized on the lead day; and then on the second and third day of those hearings, you can talk about anything you want. There was an effort in the lead to try and identify a theme that would be the most important. So, for example, the San Francisco conference on October 7 through 10 is emphasizing "Strategy through Energy Conservation" or how can we reduce the U.S. demand for energy? The one in New York is emphasizing "Capital Requirements for Project Independence" because we want the benefit of inputs from the financial people on Wall Street. Turns out, that's also emphasizing international implications of Project Independence, and I could go through the rest of these. The major themes are for the first day, and after that, it's open. You can talk about energy conservation in New York on the second day and the third day, but there are thematic empathies in this thing.

DELEGATE: Is attendance there by invitation or are there two public hearings?

BAUER: The Regional Administrators are the ones that are working out the agenda on that. It's a true public hearing as far as the second and third days. The first day, I think, will be structured agenda that we're trying to get certain key people in to comment on these theme areas. I know anyone can participate on the 2nd and 3rd day; but probably to get on the agenda, you will want to call into the Regional Administrator, and say that you want to comment, and then he works you into the agenda. These hearings will probably start at 8:00 in the morning and go through to 10:30 or 11:30 or 12:00 at night each day and maybe longer to try to give as many people as possible the opportunity to speak.

KRESS (Shell Oil Company): Also to the young people here--it's a true public hearing. It should be pointed out that they can participate.

BAUER: Right.

DELEGATE: The recommendations will be submitted to the President, and then will he go from there?

BAUER: Yes, the implementation would be multiple, obviously. There are things the Executive Branch can do on its own. There are things that require legislative action. There are things that are really recommendations but are not executable by the Federal Government at all, but represent a position that the Federal Government has taken on what ought to happen in the states, or what ought to happen in the individual cities; so the implementation of this would have multiple ramifications.

DELEGATE: You said that by 1980 we could save, I believe, 7 million barrels per day of oil. Is that what you said?

BAUER: 8 million.

DELEGATE: 8 million. The Shell report says that by 1980, we could save 3 million barrels and by 1990, 8 million barrels. I was wondering if you could explain the discrepancy?

BAUER: I can explain what we did for our calculations, but I can't explain what Shell did for theirs. What I can say is that our basis for that was the reference energy system at Brookhaven and such projects by detailed industrial grouping, residential grouping, transportation grouping on what energy growth is, and the savings that we are claiming of 8 million barrels a day by 1980. This is a consequence of all of those conservation measures that we could identify that are cost effective; that is, measures which to the institution or individual would be in his best interest to do. For example, we were talking about insulation. There would be that amount of insulation accomplished, in fact, in the country. For the homeowner, it meant that he would be saving money by putting insulation in, relative to the fuel costs he would otherwise be having to pay.

It might well be that Shell went through a separate process. I don't know. We have Shell here; they can comment on it. Are people likely to do that? Are people likely to operate in cost-effective ways? What's the probability that all institutions and all people would do the things that are cost effective for them? For example, take insulation: If a homeowner feels he's only going to live in a house for three years, he might say, "Well, why should I put insulation in my home when it's going to take me five years to recover that investment because I won't be here anyway?" So, that might lead to why their assessment might be more conservative than ours.

KRESS: Whenever you do forecasting work, or for that matter, whenever you make a calculation, particularly in the social area, the premises that you set up are really the answer. One thing I think of that might make a difference: In transportation savings, I think we used an average of 1.4 passengers per car where I think you used 1.6.

BAUER: That's for urban transportation.

KRESS: Then they went to 3.2 as a possible goal. I think we went to 2.0. Well, we're going to have to increase the number of people riding in cars. I don't think you're going to get the average up to 3.2. The other thing is that these numbers are guesses. Some guy in his group says, "Well, look, you have a number and you have a number, etc. Here is the number we're going to use." He picks a number out that suits him individually.

DELEGATE: I was just wondering because Shell looked pretty optimistic. I don't know what theirs would be like, but it seems a little bit unreasonable.

BAUER: No, Shell is less optimistic. They are more conservative.

DELEGATE: They're optimistic, and I'd like to see what yours is; I just can't believe it.

KRESS: What's your basis for not believing it?

DELEGATE: I have a hard time believing what Shell has come down to here.

KRESS: If you can come up with another forecast, we'd be very happy to believe it.

DELEGATE: I was wondering as part of its energy conservation program is there any study or overview being done of not only the regulatory rules of say the Interstate Commerce Commission (ICC) and the alphabet soup agencies, but of the Federal Government as a whole including the tax codes in order to promote maximum energy conservation policies?

BAUER: We're embarked on that. As you know, in President Nixon's economic address in California a couple weeks ago, he mentioned that one of the priorities that he now, presumably, and others are involved in is a review of the entire regulatory structure to see to what extent it's affecting our inflation within the country. We have a subset of concerns that relate to the extent to which they are driving inefficiencies that are in the transportation mode, transportation activities particularly. The issues also come up in terms of the Federal Housing Administration's (FHA) codes. How can you use entitlement to mortgage assistance, for example, as a lever to encourage people to buy, or make mortgage money available potentially, or home improvement loans available to people who entertain the possibility of going back in their homes and doing things that will, as we say, retrofit them for more energy efficiency. So, we are looking at those in context that way: the buildings and housing areas on one hand and transportation on the other. I'm not sure, is that what you're getting at?

DELEGATE: Right. Also, is anybody taking a look at the tax code to see what could be done here to promote the most use of the car with the higher efficiency say giving a tax credit of 13¢ per mile?

BAUER: Yes, we are. We have thought of labeling this one thing. You can talk about various excise taxes that could be imposed and that are graded in terms of efficiency or weight or whatever. You've got some very practical problems. If you change taxes, the tax structure, you obviously have to get through Wilbur Mills on the House Committee. It's not an easy thing to get various taxes passed so in the meantime, we're proceeding on the labels option trying to get better signals out there to allow consumers to make what we would say would be more informed choices as to what kinds of products they should buy. We have not eliminated the notion of taxation option.

Trying to describe it further: it raises a very fundamental philosophical point too. If you look at the so-called regulations that we're looking at, they were motivated by other values that we've had in the past in our society. I guess what we're saying is that if you take any single value and run with it, you get yourself in trouble because ten or fifteen years down the pike, you're going to find out it's distorted what would have happened in the market place. The most obvious example which you've undoubtedly gone into is the whole natural gas regulation system which drove this energy problem into its most current form. Most recently the price of natural gas in interstate shipment obviously is much less than its value for the end uses to which it's put. That's been the result of regulation.

If you think of taxes as being another kind of regulation, an incentive kind of thing, you're distorting what's going on in the market place. You want to be very careful with that, because you're going to lay the seeds for downstream problems that you can only vaguely anticipate at this point in time. So, you'd rather see how can you perfect the market place to sort out these choices. How can you remove distortions now that don't permit a good or a service take on its true value, its true worth?

DELEGATE: The FHA is making money available for home loans for home improvement. Is the FHA or any other federal agency going to be making money available or trying to make money available for these home improvements at reasonable mortgage rates?

BAUER: Yes. At the moment it's an option, but by next November 15, we will have such loans available in these amounts. We are certainly pushing that option to the point of being a mature option that is a choice that can be made in the federal system. We are well aware of what might be the value of that, and we are very concerned about trying to accomplish an incentive that would permit people to retrofit homes. We got 60 million buildings in the U.S. and parts of the country that aren't built up, particularly, in the Southwest and so on, but if you get on up toward the Northeast or in large portions of this country, it's already there, so your margin in terms of just setting standards for new construction is not enough to meet the kinds of independence self-sufficiency criteria that we want to have accomplished by 1980. You gotta do something with existing homes and existing buildings. So, we're very concerned about getting into the home improvement business, and we are working actively with Housing and Urban Development (HUD) on that, as well as with the Congress to cause that to happen. I think it's an important option to develop.

DELEGATE: Do you have any information on the optimum system for installing extra thermal insulation? Do you have anything on that?

BAUER: Well, it varies depending on where you are and the kind of home you're talking about. We are proceeding to develop with Dubin Associates in New York a series of manuals that will be freely available which will talk about how you retrofit commercial buildings; how you retrofit specialized institutions; the churches are involved as one of those buildings as well as office buildings, and homes. In addition, we have a project underway with groups in both Tepeka, Kansas, and in Danbury, Connecticut, in which we're providing a questionnaire to people. They describe their homes, then with this questionnaire that laymen can fill out and using the best models that we can find in the country, we're advising them on what they can do to improve their homes, how much it will cost and how long it will take them to recover these costs in saved fuel. This effort is being expanded to five additional cities soon. The response has been good.

So, that's the way we're proceeding on that. We intend to seek in the retrofit activity to put out, as I say, some manuals and other information that will provide to other cities information that they can utilize.

DELEGATE: It seems to me that what you're saying is that you're trying to establish a balanced energy budget and trying to put energy as a top priority in Federal planning, is that correct?

BAUER: I'm trying to make sure that energy takes its legitimate place before the bar in which very critical choices are being made about how we're developing the country, and I'm saying that issue of the energy consequences of public actions or of private actions has not been adequately represented. I don't claim that we should build the country or run the country strictly based upon energy. That's not correct. It's one of many values that has to decide what kind of a transportation system we have, what kind of homes we live in, where we work, the kinds of processes that are involved in work; but it has got to be raised to the point of consciousness which it has not been in the past.

We haven't had to in the past. The old game, you know, about energy is whenever you try to build something, you look for the goodies. In the past, one of the goodies has been: energy is cheap, and it's abundant. Great, then you take out all your degrees of freedom with that. You've got so many other things that are constraining you that you look for those wherever they are. What we're saying is that we're running into trouble with the boundary conditions. It's not cheap, and it's not abundant. Not in the forms that we need it. So, now we've got to do a lot of rethinking and move the fact that it's not cheap and abundant into our consciousness, and that's what we're trying to do.

I've tried to present a balanced view of conservation. I didn't come down here with a flag in my hand saying what the world should be in terms of energy conservation. We've gotten in trouble doing that in the past. I think it's one value just as is environment, entitled to take its place. Environmental protection takes its place, but you cannot build a country and operate a society, keep people employed, provide the amenities that they demand if environment becomes the value, the criteria. That's all I'm saying--that's why "balance" is such a key word. Incidentally, one of the important effects of energy conservation is that it's good environmentally.

DELEGATE: In the past, take environment, for example, and the environmental policy, one of the means they used was first to pass an environmental policy act. Are you going to pass an energy policy act, and if so, are you going to use something like the 102 section which requires an energy impact statement, that type of procedure, or are you going to change that?

BAUER: Well, I think we would like to modify the Environmental Impact Statement as it has been modified to incorporate energy implications as well. For example, the Environmental Impact Statement (EIS) submitted for large public construction and is now the section that says, for example, for a power plant: What could you accomplish in the region in which you are serving by going to energy conservation measures that are suited for the region where you are located? It's a different problem for Commonwealth Edison of Chicago than it is for Arizona. The point is that if you can defer building a power station at Four Corners (which has been a contentious station for years)--if by conservation measures, you can defer the construction of a large scale power plant, if it's inevitable thermodynamically to have some kind of environmental effect; by conservation, you've got to spell out that option. That, to me, seems eminently appropriate. But, I don't think it would be helpful to have a global energy act, so-called, given the implementation of that. It depends on so many other things that are not energy. They depend on how we build a transportation system, and there are, frankly, problems in my view in respect to laying out these hardened targets.

I'll give you a classic example we're wrestling with right now: thermal effluent standards for power plants. By 1977, the power plants are not supposed to have any heat at all going into rivers. You've got to go back and retrofit those power plants so that they don't (with cooling towers or whatever) put heat into the rivers. O.K. Is that wise? In terms of a broader view of all the issues involved? If that means I have to take those power plants off the line in order to accomplish that retrofit and these are large power plants (500 megawatts) which are the backbone of the electric utility industry in this country and the most efficient plants relative to either gas turbine units or whatever. Is it wise in terms of all the issues involved to bring those off line and dump the increased load onto gas turbines or lesser efficient units that exist in spinning reserve right now, or is it wise to say: Is that effluent standard to be met by time definite 1977? Should that be relaxed in some kind of rational way, so we can handle both the energy fact of that standard as well as the ultimate environmental protection we want? I don't think we want to get in the same trap on energy. Now, we could get ourselves in a situation where no one is going anywhere and no goods are being moved but I'm not sure that's what we want in this country.

DELEGATE: What powers would the FEA have to control the development of inefficient modes of transportation?

BAUER: The FEA is an organization, as you know, that's supposed to have a two-year life span. It has no regulatory powers except those that it has implicitly in the allocation of fuels. Those are powers which, as you've been reading, John Sawhill's very interested in moving away from. He'd like our involvement in the whole allocation of fuels business, certainly not to be a permanent structure in the economy. It's a persuasive role. It's the role, in fact, most agencies find themselves in: to try to change regulations that the Interstate Commerce Commission (ICC) might have and to shape policy because of the energy consequences of the actions that are now moving on. We have no right to regulate transportation in the country, and it would be ill-served if we took on that right. Is that answering your question?

DELEGATE: If you wanted to stop the development of airplanes because of their inefficiency, let's say you only wanted to use airplanes for long distance flying, and you wanted to use maybe rail as an alternative for more localized travel; would the FEA have any power to accomplish that?

BAUER: Our power would be as follows on that: We are concerned with that issue or what might be our interest as you're stating in far blunter terms than it would be. I don't think we're in the business to stop airplanes. I'm sure that's not what you meant, but I think the way we would proceed on that--say "Look, here's the airplane industry, the aircraft industry, the transportation of the U.S. Here's the railroad industry. Here are the alternatives that appear to be available. Here is the structure of the Civil Aeronautics Board (CAB) regulations as they pertain to aircraft." This is the direction that those sets of regulations are driving us, pushing more and more people into more and more energy intensive modes. We think it, therefore, appropriate that they be changed to the following ways and we're going up to the Hill to do it with a bill.

If that bill had any chance at all, we would have to have lined up all kinds of ducks in advance otherwise it's a fun and games exercise. You'd have to have the Department of transportation (DOT) lined up with it. You'd have to have some kind of consensus on the part of CAB, otherwise, you're playing a game. I think that's the process you'd go through to change it. We're in that process right now of identifying what the impacts of current regulations are. We were very much behind the increase in load factors. We did that. We also were behind the reduction of certain en route cruising speeds. We did that, with CAB and with DOT cooperation.

MURRAY (Center for Strategic & International Studies): We're talking about conservation of 7 or 8 billion barrels a day within the next five or seven years. Yet, you seem to be wrestling and groping with the problem should FEA become involved in bringing this about.

BAUER: We're involved.

MURRAY: Yes, but you're debating whether you should have an active or passive role.

BAUER: No problem about active or passive role. I'm talking about the kinds of things that you can really do.

MURRAY: Then if you're taking an active role, what are the specific active measures that will bring this about? That's what I think the student wonders.

KRESS: Well, Doug (Bauer), doesn't it get back to your philosophical point? The basic point that we're arguing about is whether the private sector through the free market pricing system is going to control all these things by a sort of automatic control. The price goes up, the demand presumably goes down, and the supply goes up so they balance out again. This is a continuing process regardless of what the subject is--food, energy, or real estate. The free market system is always doing this automatic balancing. The other side of the coin is a plan which says, "Ah, we're smart enough now. We know what the future's going to bring, and therefore, we're going to set up the rules to do this and that and the other thing, and I think everything will work out just dandy." I don't know which side to take. I'm not taking any sides; but I'm saying, isn't that the basic argument? Is it going to be channeled through this sort of automatic pricing system or is it going to be channeled through plans, through walls of regulations?

MURRAY: Are we going to hope that this conservation comes about through some kind of divine guidance?

DELEGATE: That's the issue, again. Who's to be making these decisions? Should it be the Federal Government, should it be at the initiative of these people who are in the transportation industry, or what? What are we supposed to be doing here? I think we need to talk about who should be doing it, and whether or not we think the Federal Government should be involved, and then if they should be, let's see what are some good positive action the Federal Government can take.

DELEGATE: For two days around the edges of this thing--we've finally gotten to where we're at--right there is the whole question of what we're doing. This country is built on a particular kind of system. It's built on a free market system; however, much of it may have been tampered with and muffed up until now. We have to make a decision, and I think this is what we ought to concern ourselves with rather than a whole mass of details. Until you have an overall policy, the details don't do you a damned bit of good. What we have to concern ourselves with, I think is: These decisions have to be made. Who makes them? For instance, the railroads: We set up four transcontinental railroads. Three of them with government money--all of which failed--and one private one, which is the only successful one. Are we going to do it by the system which is the system that built the economy--the free market system? That's the basic question. All the other stuff is a bunch of smokescreening. The question is do we give it to a proven inefficient, corrupt method of handling power--the Federal Government.

DELEGATE: The basic question here to start out with was: What authority does the FEA really have to enforce its policies? So far, we really haven't heard anything. We've heard that they can suggest something or this or that, but they can't really enforce anything. What we're asking you is what can FEA do? What measures do they have now?

BAUER: They have allocation authority, and that's not a trivial one.

DELEGATE: Is it more or less like the tri-state where they say--we'll hold back federal money if you don't fit into this plan? You don't have any money power?

BAUER: No.

DELEGATE: How much money do you allocate?

BAUER: Money?

DELEGATE: No, they allocate gas.

BAUER: We've got 5 million dollars worth of research in the fiscal year just ended, and about 6 or 7 million dollars in the current fiscal year.

DELEGATE: What are you mainly interested in?

BAUER: We're interested in engaging in activities that will expose what kinds of energy conservation actions can be undertaken. I've mentioned several of them: the projects in Topeka, Danbury, etc. We have industrial work underway to look at 6 or 7 major industries to find out how they are using energy. What the thermodynamic limits on that energy usage would be, and to what extent the present structure of both free market forces that they're affected by and regulations and incentives affect the way they use energy, so that we can work cooperatively with them to define explicit goals for how the efficiencies could be increased. How we can transfer technology from other parts of the world, as for example, with the NATO committee for the challenges to modern society on into our own economy to improve the efficiency by which we produce cement, for example--steel, paper, glass, and the like.

We also have work, as I've indicated, in transportation. I thought this was the area you wanted me to emphasize in relation to the effects in the regulatory structures. We've got works in the Lindenwald line in Philadelphia to see how much energy is being used versus the kind of system that would be different from the Lindenwald mass transit system. I've mentioned the manual development activity that's underway in the buildings area. In systems studies, we are working on trying to improve the land use model or the reference energy system to be able to permit a tool to be available for local planners to assess the impacts of alternative land use choices as far as the energy and environmental consequences are concerned. So, there'a a broad variety of research activities that we're involved in.

Student Delegate Energy Resolutions

RECOMMENDATIONS FOR A NATIONAL ENERGY POLICY

by

THE STUDENT DELEGATES TO THE NATIONAL ENERGY YOUTH CONFERENCE

NEYC RESOLUTIONS

WHEREAS, past and present attitudes and economics encourage the wasteful use of energy and other resources; and

WHEREAS, waste products can often be reused to conserve new resources;

THEREFORE, it is recommended that:

> City, county, and state government agencies, with any necessary technical assistance for Federal Agencies, should sponsor research or cooperate with industrial research to develop additional and improved methods of waste resource recycling.

WHEREAS, great quantities of heat energy are lost because of poor insulating materials and techniques; and

WHEREAS, a reduction of heat loss would and does result in substantial energy savings;

THEREFORE, it is recommended that:

> Energy research and development funding for the improvement of insulation materials and techniques; and efforts of energy producers aiding the public in the improvement of residential and commercial insulation techniques be commended.

WHEREAS, the total world supply of liquid hydrocarbons is finite, and is quickly being depleted; and

WHEREAS, liquid hydrocarbons are valuable for non-energy uses such as petrochemical production;

THEREFORE, it is recommended that:

> The United States curb the use of petroleum and natural gas to generate electricity and concentrate on using those fuels for manufacturing and other non-energy uses.

WHEREAS, present predictions indicate that coal will increase in importance as a fuel source in the future; and

WHEREAS, most known coal reserves are most economically recovered by strip-mining; and

WHEREAS, strip-mining can present dangerously damaging environmental effects;

THEREFORE, it is recommended that:

> Agencies of state and federal government, private industry, and educational institutions engaged in scientific, and technological research and development direct additional effort toward improving mining technology and strip-mine land reclamation procedures.

WHEREAS, the nation needs to increase energy resources; and

WHEREAS, the nation needs to protect her valuable agricultural land resources;

THEREFORE, it is recommended that:

> A National Land Use Policy be established to help determine priorities for energy resources, with reference to protecting land resources.

WHEREAS, twenty-five percent (25%) of all energy consumed in the United States is utilized for transportation; and

WHEREAS, transportation sectors perform at lower efficiencies than any other energy-intensive sector in our economy; and

WHEREAS, the transportation sector is at present highly dependent upon fossil fuels and will remain so in the near future;

THEREFORE, it is recommended that:

> Agencies of state and federal government, private industry, and educational institutions engaged in scientific and technological research and development direct additional effort toward improving transportation systems, energy efficiency; and that
>
> Such research be coordinated by the Energy Research and Development Administration and the Department of Transportation to include adequate safety, convenience, cost-effectiveness, as well as energy-efficiency criteria in the overall transportation plan; and that
>
> Additional economic incentives, personal convenience incentives, and public information activities be developed to promote the public and private use of smaller and fewer automobiles and existing transportation systems.

WHEREAS, the environment of space offers tools with which mankind may improve life on earth; and

WHEREAS, space technology can be used to aid improvements in communication, transportation, and the search for new energy sources;

THEREFORE, it is recommended that:

> The National Aeronautics and Space Administration direct the bulk of its current efforts toward developing technologies which will aid in the solution of the energy problem; and that
>
> The United States Congress review its appropriations to NASA with due consideration of this contribution to Project Independence.

WHEREAS, many nations of the world are conducting studies in energy such as nuclear fusion, Breeder reactor research, fusion, and MHD, to name a few; and

WHEREAS, energy is a worldwide problem; and

WHEREAS, much expensive and time-consuming duplication could be avoided if international cooperation were expanded; and

WHEREAS, many other benefits come from international friendships resulting from cooperation;

THEREFORE, it is recommended that:

> The United States Congress propose the development of a world energy administration under the auspices of the United Nations in which all nations would cooperate.

WHEREAS, nuclear power poses a potential hazard to life; and

WHEREAS, decisions concerning nuclear power will be with us for many generations to come;

THEREFORE, it is recommended that:

> The expansion of nuclear power be accomplished with maximum care and concern for sitings with respect to human health and the environment and for security arrangements.

WHEREAS, the delegates to the National Energy Youth Conference have considerable knowledge, interest, and concern for the development of viable energy policies; and

WHEREAS, our future depends heavily on decisions presently being made regarding energy research and development priorities, conservation efforts, and many other vital areas;

THEREFORE, it is recommended that:

> An Ad-Hoc Committee be formed, comprised of delegates to this conference to undertake detailed investigative research of the technologies which promise to supply energy in the future; and that
>
> Conclusions of the Ad-Hoc Committee be used to construct a student-originated set of goals, and a plan of action which will bring about these goals.

WHEREAS, new alternative energy sources need immediate research before they become usable on a large scale; and

WHEREAS, college students of science, technology, and engineering often engage in work that does not contribute in a meaningful way to the problems of society, such as energy; and

WHEREAS, there is much constructive potential in college students for research;

THEREFORE, it is recommended that:

> Increased financial and material resources be made available for qualified college students to conduct research on energy resources, distribution, and use; and that
>
> Academic credit be given by colleges for such research along with all other viable incentives for students to become involved in the energy problem; and that
>
> FASST be authorized by ERDA and otner energy industries to establish an annual energy projects competition, and to administer a scholarship to the most useful contribution developed by the students.

WHEREAS, the energy problem affects every level of government;

THEREFORE, it is recommended that:

> Comprehensive energy policies be formulated to bring about greater coordination and harmony between federal, state and local government agencies whose decision affect energy industries, in order that equitable policies be established at all government levels.

WHEREAS, artificially low prices in regulated utility industries encourage an unwise usage of energy; and

WHEREAS, certain tax privileges and exemptions tend to distort relative costs in exploration and allocation of energy resources; and

WHEREAS, the present pricing mechanisms do not reflect broader social costs;

THEREFORE, it is recommended that:

> The United States Congress examine special tax privileges to the oil industry; and that
>
> The United States Congress eliminate price regulations of natural gas to allow market pricing to reflect relative costs of energy resources; and that
>
> The United States Congress institute a peak-load pricing system for the sale of electricity; and that
>
> The United States Congress require that full social costs of energy consumption and production be paid by those consuming it.

WHEREAS, the regulations of the Federal Regulatory Commissions have a vital role in determining America's economy; and

WHEREAS, America's economy is a large user of energy and raw materials; and

WHEREAS, some regulations which at one time were deemed vital to America may have been rendered obsolete, and in fact, counterproductive to our interests today due to the changing energy-economic situation;

THEREFORE, it is recommended that:

> Thorough survey of the regulations of the Federal Regulatory Commissions be undertaken by the General Accounting Office or a like body in order to determine what regulations may be obsolete and should be changed in order to increase our energy-use efficiency.

WHEREAS, public awareness of the energy situation is a major key to resolving the energy crisis; and

WHEREAS, energy conservation is absolutely essential if the United States is to become independent in energy; and

WHEREAS, energy conservation can be accomplished without harming our standard of living; and

WHEREAS, the American public must be well-informed if any cooperative energy conservation program is to be successful; and

WHEREAS, many energy industries have prepared materials on conservation, technology, economics, and other critical areas of the energy problem to inform the public about ways private citizens may act to help the situation; and

WHEREAS, the United States Energy Research and Development Administration has supported FASST's National Energy Youth Conference through provision of speakers, representatives, materials and financial assistance;

THEREFORE, it is recommended that:

The FASST Energy Youth Council and the delegates to the National Energy Youth Conference commend ERDA and the energy suppliers for their efforts in improving public understanding, and for their interest in communicating between youth, industry and government; and that

A comprehensive information program be implemented by all levels of government, industries in the energy field, and organizations such as FASST to present the facts to the American people, make them aware of our long and short-term energy problems, and give viable suggestions to them for ways to save energy.

Biographical Sketches

STUDENT DELEGATES' BIOGRAPHIES

LAURA ANN ARNOLD, West Lafayette, Indiana, is a natural resources-environmental science/biochemistry major at Purdue University. Age 21, Laura, for the past three years, has been involved in the National Science Foundation's Student Originated Studies program in the university's bionucleonics department. She was subcommittee chairman of the Aquatic Invertebrates (1972), Environmental Indicators committee member (1973) and Student Project Director of the NSF/SOS program (1974). She participated in the NASA-NSTA Youth Science Congress (1971), the Youth Conservation Corps and the Missouri Youth for Environmental Quality Conference (1971). At present, she has articles about the NSF/SOS program in preparation for Environment magazine and the Journal of Environmental Education.

JOHN E. BURNETT, Corvallis, Oregon, is a chemistry and biochemistry major at Oregon State University. Age 26, John has been involved in the National Science Foundation Student Originated Studies program and has also been connected with government research projects with the Department of Agriculture, the Environmental Protection Agency, and the U.S. Marine Corps. He completed a lecture circuit of Oregon Community Colleges in 1967 and has been a guest speaker at private college English workshops. He was an instructor for the Marine Corps, 1st Division, Division Schools, Da Nang, South Viet Nam and Officer Candidate School, Quantico, Virginia. Ultimately, he wishes to teach and do research on the college level and is most interested in the biochemical solar conversion and efficiencies of natural systems related to the total energy problem.

JON COOPERSMITH, Princeton, New Jersey, is a political science/engineering major at Princeton University. Age 18, Jon has worked with NASA and the Senate Aeronautics and Space Sciences Committee on various projects, as well as being a senate page. In 1974, he presented a paper entitled: "Paper Titan: The Peace Use of Space" to an American Institute of Aeronautics and Astronautics (AIAA) Regional Student Meeting which was later published in the Congressional Record. He has published numerous articles on technology and its effects with his own photographs as illustrations. His interests regarding the energy problem primarily lie in socio-political effects and "exotic" technological aspects such as the MHD and the SPSS.

RALPH V. DAUGHERTY, Terre Haute, Indiana, is a chemistry major at Indiana State University. Age 19, Ralph has conducted research which successfully formulated a process for the production of methan gas and a soil conditioner. He was a junior author of a paper entitled "Enterobacteria in Feedlot Waste" which was published in the Journal of Applied Microbiology (1972). A member of the American Association for the Advancement of Science (AAAS), the Irish American Cultural Institute, FASST, and Mental Advancement, Ralph is presently working on a book concerning his theory regarding the Transmission of Electricity from the absorption of color frequency from florescent microbes. He plans to continue his education until he receives his Ph.D. which he hopes to acquire within five years.

SYLVIA ANN DI SANTI, South Gate, California, is a journalism major at the University of Southern California. Age 22, Sylvia has written articles on the energy crisis and its effect on the university as well as conducting an independent study project on geothermal energy. She was selected to be the USC student delegate to the Independent Students Newspaper Association Conference (1973) and represented USC at a New York Newspaper Workshop sponsored by the Overseas Press Club. She is current editor of the USC newspaper and hopes to enter business or industry as a public relations representative after graduation. She has an interest in the future of alternative energy sources, i.e. solar and other technological advances.

JIM DUBERT, Ames, Iowa, is an agriculture/journalism major at Iowa State University. Age 20, Jim received two awards from the Army and the Air Force for Scientific Achievement and First Place State Award for Agricultural Electrification from the Iowa Future Farmers of America (1971). He is a member of the Phi Eta Sigma Academic Honorary, the Board of Directors of the ISU Daily, Inc., and the Board of Directors of the Iowa Student Public Interest Research Group. His main interests are public speaking, politics and farming.

LARRY A. FROST, Seattle, Washington, is a history major at the University of Washington. Age 21, Larry has completed two years of a physics/mathematics curriculum despite his history major and has actively studied almost all of the non-biological sciences. He has written articles for the UW DAILY, the Walla-Walla Union-Bulletin, the Associated Press and United Press International and has had a Daily editorial reprinted in the Seattle Post-Intelligencer. Larry's interest in the military has resulted in his study of the more sophisticated weapons technologies to a greater extent than any other area (this includes many of the space systems developed by NASA).

BOYD JAY HANSON, Spanish Fork, Utah, is a zoology major at Brigham Young University. Age 23, Boyd recently completed an unpublished study on the diatoms of the rubble area of Goshen Bay, Utah, and has been studying the life history of the Ambrysus Mormon in Utah Lake. He is a student project director of the National Science Foundation Student Originated Studies project studying plankton using field data and ERTS-1 imagery. Boyd is interested in ecological considerations of the energy problem, and future planning to find new energy sources and distribution methods. He plans to enter graduate school and work for a master's in Freshwater Biology.

MARTIN E. HICKS, Ellensburg, Washington, is a biology major at Central Washington State College. Age 21, Martin conducted research on the effects of thermal pollution from thermal electric plants on salmon; on the hatching of caddis fly and the effects of pesticide on the population growth of a freshwater bacteria as well as a genetics study concerning the G-banding in two different species of Microtus sp. He also conducted a small study concerning consistency of G-banding in human chromosomes. He observed the launch of Apollo 12 (1969) and gave a slide presentation to numerous civic groups and was in charge of water analysis on the Washington Water Power Company. He is most interested in the environmental side effects of production of large quantities of electrical energy and the effects of nitrogen producing hydro-electric dams on aquatic life as well as the economics involved in solving these problems.

LIDIA LLAMAS, Bronx, New York, is a chemical engineering major at Manhattan College. Age 21, Lidia participated in a research grant on air pollution control under the National Science Foundation's Student Originated Studies program and was nominated student project director. She is a member of the staff of the Manhattan Engineer, a school magazine, and is in the process of forming a student chapter of the Society of Women Engineers at her college. She is concerned with the misuse and abuse of precious raw materials and energy as one of the greatest pollution problems and hopes to obtain a master's degree in environmental engineering.

COLLEEN T. LYNCH, Aledo, Texas, is a student at Western Hills High School. Age 17, Colleen is a member of the Texas Academy of Science and the North Texas Biological Society. She has the honor of being one of two junior members to have a paper accepted by the Texas Senior Academy of Science, has been on two television science programs and won a first place Navy award, a second place NASA award, first place Fort Worth Geological and Geophysical Societies awards, and the Army Outstanding Student award for her Oil Shale research project. Colleen hopes to attend the University of Texas at Arlington upon graduation.

BENJAMIN MAX MONDSCHIEN, Miami Beach, Florida, is a biochemistry major at Yale University. Age 19, Ben participated in the Dade County Laboratory Research Program where he conducted research at the Miami Heart Institute. During high school, he organized a Science Honor Society affiliated with the Florida Academy of Sciences and the Science Clubs of America. He was selected to be a permanent member of the Yale delegation to the Connecticut Intercollegiate Student Legislature and was founder and representative of the Yale Freshman Class Council. He has presented a paper at the annual meeting of the Society for Experimental Biology and Medicine (1973) and at the Fifth Annual Midwest Medical Research Forum (1974). He plans to become a research scientist.

KEVIN J. MURPHY, Washington, D. C., is a biochemistry major at Catholic University of America. Age 21, Kevin is involved with the National Science Foundation's Student Originated Studies program conducting research on the use of bacteria as a future food source for animal consumption. He is an active member of both the chemistry and biology clubs at college and hopes to go on to graduate school immediately after college.

MARK B. NERHEIM, Kirkland, Washington, is an economics major at the University of Washington. Age 20, Mark participated in an expositional debate concerning the transportation of oil via supertankers to the Puget Sound area. He was president of the King County Achievers Association and is currently working as a legal researcher for a group of attorneys in Seattle along with working at the University of Washington Law Library. He is interested in the economics, development, and conservation of energy resources, their allocation and distribution with regard to planning and decision making. He has received a National Science Foundation Student Originated Studies grant and plans to continue his education in graduate economics or perhaps law.

LOUIS R. PAPALE, West Orange, New Jersey, is a civil and environmental engineering major at the Newark College of Engineering. Age 20, Louis has done numerous reports on transportation, ancient engineering, geodesic structures and the uses of aerial photographs. He has received a National Science Foundation Student Originated Studies Program grant and is president of the American Association of Cost Engineers at his college. He is also editor of the Civil Engineering Papers of the SPHERE at Newark. Louis is interested in the short and long-range research and development regarding the energy problem as well as solar, geothermal and wind sources. He hopes to go onto graduate studies or obtain employment and a Physical Engineering license after graduation.

NEIL WARREN RANDALL, Potomac, Maryland, is a chemistry (pre-med) major at the University of Virginia. Age 17, Neil is in the University's honors program for the College of Liberal Arts. He was the editor of his local civic association's newsletter and won an award as the outstanding student citizen of his community. He is a member of the Washington Junior Academy of Science and worked at the National Institute of Health under an American University program, researching in the microanalytical section of the laboratory of chemistry in the Institute of Arthritis, Metabolic and Digestive diseases (1972). He was a youth aide in the Office of CATV in Montgomery County and hopes to enter medical school after college and eventually become a psychiatrist.

MARK W. SCHULZ, Shawano, Wisconsin, is a nuclear engineering major at the University of Wisconsin at Madison. Age 18, Mark was in the Honors Group of the Westinghouse Science Talent Search and served as chairman of a Student Council Energy Committee. He has done research papers on fusion and is particularly interested in nuclear fusion as well as fission and the breeder reactor. His long-range plans are to engage in fusion research.

WAYNE SIMMONS, San Marcos, Texas, is a biology major at Texas A & M University. Age 17, Wayne was Student Body President, Student Council President, National Honor Society President and Science Club President at his high school. He was valedictorian of his class and has won numerous awards in various subjects concerning science and math. He received the Bausch & Lomb Award for science, was a semi-finalist in the Westinghouse Science Talent Search and was also named to the Honors Group of the Talent Search. He is interested in science, especially in its relationship to energy.

JAMES A. STILES, Marlboro, Vermont, is an environmental science/physics major at Marlboro College. Age 20, Jim has designed a parabolic trough collector (1974) and conducted research as to the physiological effects of the oriental herb ginseng on drosophila melanogaster and E. coli. He conducted a seminar at his college on solar energy (1973) and also one entitled "Architecture and Energy". Following completion of his B.S. degree, he plans to pursue an M.S. or Ph.D. in some physics related field and would like to gain working experience in alternate energy implementation, pollution testing, and/or materials research. The area of the energy problem in which he is most interested is recycling and waste energy utilization.

KAREN ELIZABETH STONE, University, Alabama, is a chemistry major at the University of Alabama. Age 20, Karen is currently involved in an energy-related research under a National Science Foundation Student Originated Studies grant. She is a participant in the Chemistry Honors Program at the university and has done research in organic chemistry, specifically with the Wittig Reaction. She presented a paper in the education conference of the Alabama section of the American Chemical Society and is a student affiliate of the Society. She received an Alumni Honors Scholarship and holds membership in the Women's Honors Program, Alpha Lambda Delta, the Chemistry Honors Program, and the Mortar Board. Her special interest at present is the utilization of coal as a source of high energy liquids, and hopes to enter the University of Alabama School of Medicine after graduation.

MICHAEL SULLY, Missoula, Montana, is a chemistry and physics major at the University of Montana. Age 23, Mike has done several science projects such as the determination of ambient air concentrations of hydrogen sulfide and sulfur dioxide; development of a model for the prediction of dissolved oxygen concentration; determination of various meteorological parameters for the refinement of a model for the Missoula Valley airshed and was project director for the "Missoula Valley Air Pollution Study" under a National Science Foundation grant. He has been co-ordinator for the past two years of the Student Environmental Research Center in Missoula and received the American Chemical Society's Undergraduate Award in Analytical Chemistry (1974). He plans to enroll in graduate work for an advanced degree in physics.

KENNETH C. SUN, Boston, Massachusetts, is an aeronautical and astronautical engineering major at the Massachusetts Institute of Technology. Age 19, Ken participated in an undergraduate seminar on Space Based Energy Systems with emphasis on the space shuttle, the Satellite Solar Power Station and the Nuclear Satellite Power Station. He has won awards for his research project "Theorems and Conjectures on the Frequency of Occurrence of Quadratic Residues" and presented his paper at the Annual Science Conference (1973) sponsored by the Junior Academy of Sciences and the New York Biology Teachers Association. He is presently Vice President of the MIT Student House and Treasurer of the AIAA Student Chapter at MIT. He is presently working for the MIT Civil Engineering Department as a fortran programmer and has interests in nuclear and solar power systems;

(KENNETH C. SUN--Continued)
space applications; and energy management and control. He hopes to have a BS and MS in aero-astro engineering by 1977.

THOMAS A. WEAVER, Livermore, California, is a third-year graduate student in physics at the University of California at Berkeley. Age 24, Tom has done research on a variety of topics including laser fusion, astrophysics, nuclear physics, and biology. His project entitled "A Bi-angular Coordinate System" was displayed in Washington as one of the forty Westinghouse Talent Search Winners, and he has given a number of presentations to the American Physical Society, the AEC/CTR staff, and the Edison Electric Institute. He held technical leadership over several laser fusion projects including exotic (and extremely clean) fusion fuels. His career plans include finishing his Ph.D. research in Supernova theory and continuing research in astrophysics, laser fusion, and other energy-related topics at Lawrence Livermore Laboratory.

MICHAEL WILLIAMS, Fairfield, Ohio, is a student at Fairfield High School. Age 17, Mike is a member of the American Association for the Advancement of Science, the Ohio Academy of Science, the Royal Astronomical Society of Canada, and the World Affairs Club. He was honored as the Outstanding Biology Student of the Year (1973) and received the Guest Speaker-Award in Recognition of Outstanding Engineering Achievement by the Ohio Society of Professional Engineers. He was laboratory assistant at his school and is currently engaged in forming an Aerospace & Energy oriented Science Club.

Biographical Sketch

of

DOUGLAS C. BAUER

Dr. Bauer is Associate Assistant Administrator for Utilities Programs, Office of Conservation and Environment, Federal Energy Administration, Washington, D. C.

BORN: Wellesley, Massachusetts, where he was raised there and attended Wellesley public schools.

EDUCATION AND EXPERIENCE:

Dr. Bauer entered Cornell University in 1956 from which he received a Bachelor of Mechanical Engineering degree in 1961 after a five-year course of study combining mechanical and industrial engineering.

From 1961-1965, he served on active duty on naval destroyers of the Atlantic and Mediterranean Fleets. His tours of duty as a junior officer included assignments as Chief Engineer and Operations Officer on an afloat division staff.

From 1965-1967, Dr. Bauer returned to Cornell and completed MS requirements in heat transfer, fluid flow, and nuclear engineering. His thesis was in forced convection transfer.

He worked at Bettis Atomic Power Laboratory in Pittsburgh, Pennsylvania, between 1967 and 1972 and concurrently completed requirements for a Ph.D. in Nuclear Engineering at Carnegie-Mellon University (1972). His thesis involved analytical and experimental work on a power station on Xenon Spatial Control.

Dr. Bauer was one of 17 White House Fellows in the 1972-73 Class and was assigned to the Department of Transportation under Secretary Volpe and Brinegar. He performed various assignments including grain movement facilitation, international cooperation agreements with the Soviet Union on air safety, and energy affairs.

Since the fall of 1973, Dr. Bauer has been associated with the Office of Energy Conservation and Federal Energy Administration as Assistant Director for Research, Development and Demonstration; Director, Research Planning and Systems Studies; and currently, Associate Assistant Administrator for Utilities Programs (see above).

Biographical Sketch

of

ALFRED F. BORG

Dr. Borg is Group Director of Student Oriented Programs Group Education Directorate, National Science Foundation, Washington, D. C.

BORN: 1918.

EDUCATION: B.S. (Major in Chemistry) University of Washington, 1940
M.S. (Bacteriology) University of Washington, 1943
Ph.D. (Microbiology) University of Washington, 1948

EXPERIENCE:

Medical Department, Army of the United States, 1942-46
Bacteriologist, Biochemical Research Foundation, 1948-49
Assistant Professor, University of Illinois, 1949-53
Summer Course (Microbiology) Hopkins Marine Station, (C.B. Van Niel), 1950
Research Intern, Northern Regional Research Laboratory, 1952
Associate Professor, North Carolina State College, 1953-57
Professor and Head, Department of Bacteriology, Kansas State University, 1957-1967
Acting Dean of Graduate School, Kansas State University, 1961-62
Special Consultant, National Science Foundation, 1958-1966
National Science Foundation, Science Faculty Fellowship, University of California, 1963-64
National Science Foundation, 1967-present--
  Program Director, Science Course Improvement Program
  Deputy Director, Division of Undergraduate Education in Science
  Acting Director, Division of Undergraduate Education in Science
  Group Director (see above)

HONORARY AND PROFESSIONAL SOCIETIES:

Sigma Xi, Gamma Sigma Delta, American Society for Microbiology, Society for General Microbiology, Fellow, American Academy of Microbiology, American Association for the Advancement of Science.

Biographical Sketch

of

JAMES D. BROWN

As Assistant Marketing Manager, Fuel Cell Marketing, Mr. Brown shares the fuel cell marketing responsibility with the Deputy Program Manager, Fuel Cell Marketing of Pratt & Whitney Aircraft, South Windsor, Connecticut. This responsibility includes direction of the fuel cell marketing functions in the areas of government programs and the commercial areas of municipal electric power, electric cooperatives and gas utility on-site power.

Prior line marketing responsibilities have included the B-1 bomber turbine propulsion system, the Manned Orbiting Laboratory electric power generator, advanced electric power systems with Air Force, Navy and Army customers, solid rocket cases for missiles, advanced air breathing turbine propulsion systems, and spare parts management for the Westinghouse Aviation Gas Turbine Division.

Field engineering responsibilities have included the propulsion system for the P6M Navy flying boat, the F-105 fighter and the F8U-3 fighter, and solid rocket case programs.

Project Engineering assignments have included aircraft turbine engine development and Naval flight test work.

EDUCATION:

B. S. Chemical Engineering, La. State University

Aero Engineering Naval Training Program, M.I.T.

Several short courses--

Supervisory training, government contracting, field sales, system/project engineering.

Biographical Sketch

of

ROBERT COHEN

As Program Manager for Ocean Thermal Energy Conversion in the National Science Foundation/RANN Solar Energy Program, Washington, D. C., Mr. Cohen has been at his present position since September 7, 1973, and is on assignment there from the National Oceanic and Atmospheric Administration (NOAA) Environmental Research Laboratories, Boulder, Colorado.*

BORN: Indianapolis, Indiana, October 15, 1924.

EDUCATION: U.S. Navy (electronics), 1944-1946

B.S. (chemistry), Wayne University, 1947

M.S. (physics), University of Michigan, 1948

U.S. Navy Electronics Laboratory, San Diego, California, summers, 1948 and 1949

Graduate studies in physics, Purdue University, 1948-1951

Research Assistant, School of Electrical Engineering, Cornell University, 1951-1956

Ph.D. (EE Department, radio wave propagation), Cornell University, 1956

EXPERIENCE:

Physicist, 1956-1973, at the Central Radio Propagation Laboratory, (CRPL), National Bureau of Standards, Boulder, Colorado. (My part of CRPL eventually became the Aeronomy Laboratory of the Environmental Satellite Service Administration (ESSA) Research Laboratories, then of NOAA Environmental Research Labs.) At Boulder, was engaged in studies of the ionosphere, using radio and radar techniques, including six years of ionospheric research in South America.

AFFILIATIONS:

Served as American Geophysical Union (AGU) Aeronomy secretary, 1970-1973; Presently serving as Chairman of the AGU Committee on Geophysical Energy Resources and as a member of the Institute of Electrical and Electronics Engineers, Inc. (IEEE) Energy Committee.

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* Since January 17, 1975, Division of Solar Energy, Energy Research and Development Administration (ERDA), Washington, D. C. 20545.

Biographical Sketch

of

DONALD C. CURRY

Mr. Curry is Vice President and Washington Office Director for Underwood, Jordan Associates, Washington, D. C.

EDUCATION: Mr. Curry is a graduate of Hamilton College, Clinton, New York, from which he received a B.A. degree in political science in 1952, and a graduate of Johns Hopkins University, Washington, D. C., from which he received a M.A. in international affairs. He also studied law at George Washington University Law School in Washington, D. C.

EXPERIENCE: Mr. Curry has been with Underwood, Jordan Associates and its predecessor firm since 1961. Prior to that, he was with The Middle East Institute, where, as director of information and public relations, he handled a variety of writing, editing and administrative assignments. He also served as assistant editor of The Middle East Journal.

Previously, he was a researcher, writer and editor for the National Education Association, and editor of its Research Bulletin.

Mr. Curry served as a national defense analyst in the Legislative Reference Service of the Library of Congress during the 1957 congressional years, writing and editing reports, briefs and speeches for members of Congress and congressional committees. He also directed research on radioactive fallout for the congressional Joint Committee on Atomic Energy.

Previously, he was a foreign service officer with the United States Information Agency, leaving that post to enter the U.S. Army from 1954 to 1956. While on military duty, he served as intelligence officer on the Ethiopian, Egyptian and Saudi Arabian desks of the Office of the Assistant Chief of Staff for Intelligence (G-2) in the Pentagon.

AFFILIATIONS: Mr. Curry has broad acquaintanceship with the various government offices in Washington and with the national trade associations. His press and other media contacts in Washington are extensive.

He is a member of the National Press Club, and served for five years as chairman of the club's Publicity Committee; the Public Relations Society of America (Counselor's Section), The Middle East Institute, American Legion Post No. 20, and the National Democratic Club; and serves as secretary of the American Vikings Rod and Gun Club of Washington.

Biographical Sketch

of

HAROLD L. FALKENBERRY

Mr. Falkenberry is Chief of the Power Research Staff in the Tennessee Valley Authority's Office of Power, Chattanooga, Tennessee. He is involved in activities such as research and evaluation of advanced nuclear and fossil-fired power generation concepts, environmental problems, power industry computer applications, and electrical engineering research.

EDUCATION:

He is a marine engineering graduate of the U.S. Merchant Marine Academy; and a chemical engineering graduate of Auburn University; and is a registered engineer in the State of Tennessee.

EXPERIENCE:

He has been employed in chemical, machanical, and nuclear engineering activities in TVA's power program since 1951, including assignments to the Atomic Energy Commission's (AEC) nuclear energy programs at Brookhaven National Laboratory and at Oak Ridge, Tennessee, and to the British Central Electricity Generating Board.

He serves or has served on power industry-related committees for the National Academy of Engineering, the Electric Power Research Institute, Federal Power Commission, American Public Power Association, and the National Electric Reliability Council; and on Departmental Advisory Committees for Chattanooga State Technical Institute, Ohio State University, and the Argonne National Laboratory. He is a project coordinator for the US/USSR Joint Commission on Scientific and Technical Cooperation.

OTHER AFFILIATIONS:

A member of the American Nuclear Society, American Society of Mechanical Engineers, American Association for the Advancement of Science, the Chattanooga Engineers Club, and Order of the Engineer.

Biographical Sketch

of

DAVID M. FRADIN

Mr. Fradin is presently the Executive Vice-President for an organization entitled the Environmental Balance Association of Minnesota, which is a group of labor and industry leaders, farmers, and educators within the State of Minnesota concerned with environmental issues.

EDUCATION:

Mr. Fradin holds a Bachelor of Science degree in Interdisciplinary Engineering from the University of Michigan (1973), with minors in Communications, Business Administration, Journalism, and Political Science.

EXPERIENCE:

Mr. Fradin is the founder and former president of the Federation of Americans Supporting Science and Technology (FASST). He is a certified flight and ground instructor with over 1200 hours. As a freshman at the University of Michigan, he founded and organized the University of Michigan Flyers, the U-M's first student flying club, and served as its first president.

He has testified before the U.S. House Committee on Appropriations in March of 1971 and before the U.S. House Subcommittee on Manned Space Flight in March of 1972 and 1973 on the SST, the Space Shuttle, technology and youth involvement.

He is a graduate of the Department of Defense's Joint Civilian Orientation Conference, the Air Force's National Security Forum, and the Public Relations Society of America's Institute.

AFFILIATIONS:

Mr. Fradin is listed in Who's Who In Aviation. He is a member of the Committee on Industry, Technology, and Society of the American Association for the Advancement of Science, and is a member of the American Society of Association Executives, American Astronautical Society, and the Aviation/Space Writers Association.

Biographical Sketch

of

ROGER GUISINGER

Mr. Roger Guisinger is Director of the Energy Youth Council of the Federation of Americans Supporting Science and Technology (FASST) at the FASST National Office, Washington, D. C. He was also Conference Coordinator for the National Energy Youth Conference held at Oak Ridge, Tennessee.

BORN: September 18, 1953.

EDUCATION:

Mr. Guisinger is a senior at the University of Michigan studying Aerospace Engineering, Economics, Public Policy and Russian. Prior to attending the University of Michigan, he attended Northrop Institute of Technology in Los Angeles, California.

EXPERIENCE:

Mr. Guisinger organized and is present Director of FASST's Energy Youth Council in 1974 (see above). Along with being the Conference Coordinator for the National Energy Youth Conference, he headed the FASST delegation to the Third Annual Young People's Conference in Baku, U.S.S.R. He was also Coordinator of the FASST Center for Student Involvement at the University of Michigan; and developed an Apollo-Soyuz Test Project Student Exchange Project between the United States and U.S.S.R. students to be held this summer, 1975.

AFFILIATIONS AND HONORS:

Member of the American Institute of Aeronautics and Astronautics; and a member of the Aviation Space Writers Association

Biographical Sketch

of

KIRK HALL

Mr. Hall is a Member of the Staff of the Committee on Science and Astronautics for the United States House of Representatives, Congress of the United States, Washington, D. C.

EDUCATION AND EXPERIENCE:

Mr. Hall attended the Air Force Academy and received a degree in Mathematics (BS) in 1965. He then attended the University of California (Davis/Livermore) on an Atomic Energy Commission Fellowship. He received a degree in Applied Science (MS) in 1967.

From 1967 to 1972, he was on active duty with the Air Force at Kirtland Air Force Base, New Mexico. His work dealt primarily with underground nuclear weapons effects testing and evaluation.

In January, 1973, Mr. Hall joined the staff of Congressman Mike McCormack (D.-Wash.) to work on technical issues. In September, 1973, he assumed his current position with the Science and Astronautics Committee (Olin E. Teague, D-Tex., Chairman) working on energy-related policy and legislation.

Biographical Sketch

of

EDWIN F. HARDY

Mr. Hardy is Associate Director, Planning Division, for the American Gas Association, Washington, D. C.

EDUCATION AND EXPERIENCE:

Mr. Hardy joined the American Gas Association (AGA) in April 1971, as Manager of the Gas Supply Department. He was responsible for the study, evaluation, program coordination and information dissemination activities of the Association relating to gas supply.

Mr. Hardy serves as Staff Executive for the Association's Gas Supply Committee, the Committee on Natural Gas Reserves and as Observer on the Potential Gas Committee. He was promoted to his present position in September of 1974.

Prior to joining AGA, he served eight years with Atlantic Research Corporation, Alexandria, Virginia, in assignments as business analyst, engineering and production managerial positions, and plant director. He also spent five years in the technical division of Humble Oil's Baton Rouge refinery.

Mr. Hardy received a degree in Civil Engineering from the University of Virginia, Charlottesville, Virginia, and has served in the United States Navy. He is married and the father of two daughers. He lives in Fairfax, Virginia.

Biographical Sketch

of

THOMAS E. HUNT

Mr. Hunt is the Washington Media Representative for the Atomic Industrial Forum, Washington, D. C.

EDUCATION:

He received his B.A. in Communications from Washington State University in 1964.

EXPERIENCE:

For six years, he worked as a radio and television news broadcaster in the State of Washington where he covered nuclear activities at the Hanford Atomic Works.

In 1971, he joined the staff of Congressman Mike McCormack (D-Wash.), a member of the Joint Committee on Atomic Energy.

In September, 1973, he became the Washington Media Representative for the Atomic Industrial Forum.

Biographical Sketch

of

DAVE JENKINS

Mr. Dave Jenkins is the Special Assistant to the Assistant Secretary of State for Oceans, Environmental, and Scientific Affairs at the Energy Research and Development Administration (ERDA), Washington, D. C.

BORN: January 30, 1933.

EDUCATION: B.S., Bethune Cookman College, Daytona Beach, Florida, 1955

Graduate Study at Tuskegee Institute in Radiation Biology, New York, 1957

Graduate Study at Albany State College in Nuclear Physics, New York, 1958

Graduate Study at the University of South Florida, studying radiation and space sciences, Florida, 1959

Special Training in nuclear science and reactor technology at the Oak Ridge Institute of Nuclear Studies, Oak Ridge, Tennessee, 1966.

EXPERIENCE:

Special Assistant to the Assistant Secretary of State for Oceans, Environmental, and Scientific Affairs at ERDA (see above) since January, 1975.

U.S. Atomic Energy Commission, Washington, D. C., Technical Assistant to the Chairman of AEC, September, 1972 to January, 1975.

U.S. Atomic Energy Commission, Washington, D. C., Technical Information Specialist (nuclear), November, 1970 to May, 1972.

U.S. Atomic Energy Commission, Washington, D. C., Exhibits Manager for Nuclear Information, July, 1966 to November, 1970.

Consolidated High School, Lake Butler, Florida, Head of Science Department, 1958 to 1966.

HONORARY AND PROFESSIONAL SOCIETIES:

American Association of Physics Teachers

Biographical Sketch
of
W. 'WALT' E. KRESS

Mr. Kress is the East Coast Representative of the Public Affairs Organization, Environmental Conservation Department, Shell Oil Company, New York, New York.

EDUCATION:

Undergraduate--Chemical Engineering, Pratt Institute

Graduate--School of Science and Technology, Washington University, C. W. Post

EXPERIENCE:

Mr. Kress has worked for Shell Oil Company since 1942 in many capacities, including research and development work, managerial positions in operating (refining) facilities, design and economics of new facilities, consultant to executive vice-president and currently serving as a representative of Shell's Public Affairs Organization for the New England and Middle Atlantic States.

Most of his current duties lie in the area of environmental conservation.

OUTSIDE ACTIVITIES:

> "Have served in several political activities, as president of board of trustees in my church, am a fair golfer (in the 80's) and love a good trout stream."

Biographical Sketch
of
RALPH MARRONE

Mr. Marrone is Manager of Technical Research Energy Consulting Services for the Northeast Utilities System, Hartford, Connecticut.

EDUCATION: Central Connecticut State College,
B.S. Degree

Studied Electrical Engineering at
New Haven College

EXPERIENCE: Manager of Technical Services, The Connecticut Light and Power Company, 1967-1973

Heating and Cooling Coordinator, The Connecticut Light and Power Company, 1963-1967

Commercial Representative, The Connecticut Light and Power Company, 1953-1963

AFFILIATIONS: Member of American Society of Heating, Refrigerating and Air Conditioning Engineers,

The Illuminating Engineering Society,

International Association of Electrical Inspectors,

National Fire Protection Association,

Connecticut Building Congress and

Producers Council.

COMMITTEES: Member of State of Connecticut, State Building Code Committee's Subcommittee on Energy Conservation,

Chairman, Electrification Council of The Edison Electric Institute's Space Conditioning Course,

Member of the Electric Council of New England's Optimum Use of Energy Task Force, Lighting Committee and Advanced Comfort Conditioning School Task Force.

Biographical Sketch

of

DONALD L. MORRIS

Mr. Morris is Chief of Loan Management and Mortgaging Servicing for the Department of Housing and Urban Development (HUD) of the Federal Housing Administration (FHA), Nashville, Tennessee, and as such is responsible for approximately 13,000 multi-family units in the Nashville Jurisdiction.

BORN: Nashville, Tennessee, December 13, 1936.

EDUCATION:

Mr. Morris received his B.S. degree in Marketing/Economics from George Pepperdine College, Los Angeles, California, in 1961. He also completed all required course work for society of Real Estate Appraisers Senior Appraisal designation.

EXPERIENCE:

HUD-FHA, Nashville, Tennessee, Chief of Loan Management and Mortgaging Servicing, March, 1973 to present

HUD-FHA, Nashville, Tennessee, Data Appraiser/Appraiser-Multi-Family, October, 1971 to March, 1973

Employer's Personnel Service, Nashville, Tennessee, Employment Consultant, February, 1970 to October, 1971

Union Oil of California, Nashville, Tennessee, Distribution/Sales Counselor, August, 1962 to November, 1968

AFFILIATIONS AND HONORS:

Employed by Union Oil of California in the area of Distribution Marketing of all petroleum products.

Member Society of Real Estate Appraisers, National Society Real Estate Appraisers

President, Los Angeles Chapter of Pi Gamma Mu, National Scholastic Society; voted Outstanding Senior, 1961.

Biographical Sketch

of

FRANCIS X. MURRAY

Mr. Murray is Assistant Director for National Energy Programs for the Center for Strategic and International Studies, Washington, D. C., where he is primarily concerned with the economic aspects of national energy problems and issues.

EDUCATION AND EXPERIENCE:

Mr. Murray was born in Philadelphia, Pennsylvania, January 7, 1937, where he attended grammar and high school. In 1960, he received a Bachelor of Science degree in Business Administration and Economics from La Salle College in Philadelphia.

In 1961, Mr. Murray attended the University of Nebraska in Lincoln, where he received a Master of Arts degree. While at the University of Nebraska, he served as a research assistant in the Bureau of Business and Economic Research.

In 1963, he joined the Atomic Energy Commission at their Albuquerque operations office; and in 1966-67, he was awarded a fellowship to attend the Graduate School of Industrial Administration, Carnegie Institute of Technology.

Mr. Murray moved to the Atomic Energy Commission headquarters in Washington, D. C. in 1969. He served as Chief of the Systems Analysis and Materials Branch, Division of Military Applications from 1971 through early 1974. While in this position, he also served as a member of the Atomic Energy Combined Operational Planning Committee.

In 1972, he was a nominee for the William A. Jump Award which is given by the Civil Service Commission to outstanding young civil servants.

From 1967 through 1969, in addition to his work with the Atomic Energy Commission, Mr. Murray was a visiting lecturer at the University of New Mexico, College of Business Administration, lecturing in the fields of economics, finance and management; and early in 1974, he joined the staff of the Center for Strategic and International Studies (referred to above).

Biographical Sketch

of

GEORGE REEVES

Mr. Reeves is Manager of Energy Systems Applications, Edison Electric Institute, New York, New York.

BORN: Jersey City, New Jersey, October 23, 1942.

EDUCATION: B.E. in Mechanical Engineering, The Cooper Union for the Advancement of Science and Art, New York, 1964.

M.B.A. in Management, New York University, New York, 1970.

EXPERIENCE: Clarkson Industries, Inc., New York, New York, District Manager from May, 1964 to November, 1968

Edison Electric Institute, New York, New York, since 1968. Previous duties at EEI have included management of:

The AXCESS Energy and Financial Analysis Programs; and Commercial Marketing and Long-Range Market Planning.

HONORARY AND PROFESSIONAL SOCIETIES:

The American Society of Mechanical Engineers; the American Society of Heating Refrigerating and Air-conditioning Engineers; Chairman of Handbook Subcommittee on Energy Calculations; Vice-Chairman of the Technical Committee on Computer Applications; a member of the Technical Committee on Large Building Airconditioning Applications; and a member of the Standards Project Committee for New Building Energy Conservation.

Mr. Reeves also has written numerous articles and papers on energy and energy analysis.

Biographical Sketch

of

H.K. 'KEN' RIGSBEE

Mr. Rigsbee is the Educational Communications Representative for Public Affairs for Phillips Petroleum Company, Bartlesville, Oklahoma.

BORN: He was born in Houston, Texas.

EDUCATION:

Mr. Rigsbee received his B.S. degree in Architectural Engineering from the University of Texas at Austin.

He is a Registered Professional Engineer in the State of Texas.

EXPERIENCE:

He started his career with Phillips as an Engineering Trainee in the Engineering Department's Bartlesville office in 1966. He has worked as a Design Engineer in Bartlesville; a Construction Engineer in Raleigh, North Carolina, and Kenai, Alaska; a Management Analyst, Executive Department; and a Senior Projects Analysis Engineer for the Gas & Gas Liquids Department.

He is a member of the Administrative Board of the First United Methodist Church; Bartlesville's Board of Education; a director and past president of the Texas-Exes Club; past president and chairman of the Oklahoma Engineering and Technology Guidance Council; and has been active in the Jaycees and the Technical Careers Advisory Committee.

He has served on various professional and educational committees and was named Bartlesville's Outstanding Young Engineer for 1973-1974.

Biographical Sketch

of

JANET SERIPCA

Ms. Janet Seripca is presently a Policy Analyst for the American Petroleum Institute, Washington, D. C.

BORN: September, 1949.

EDUCATION:

Ms. Seripca received her B.A. in Political Science from American University in Washington, D. C. in 1971.

EXPERIENCE:

Ms. Seripca has been with the American Petroleum Institute since 1971. Her previous duties at the American Petroleum Institute have included the following:

Secretary to the Budget Manager for Environmental Affairs Division in 1971;

Administrative Assistant for Administrative Services in the Personnel Department in 1972;

Staff Assistant in the Public Relations Department, in charge of answering public inquiries in 1973; and

Policy Analyst, doing research on various policy position for API since 1974 till present time.

Biographical Sketch
of
RICHARD B. SCHEETZ

Mr. Scheetz is the Coordinator of Educational Services for the Edison Electric Institute, New York, New York.

EDUCATION:
Ed.D., Temple University, Philadelphia, Pa., 1958
Ed.M., Temple University, Philadelphia, Pa., 1950
Franklin and Marshall College, Lancaster, Pa., 1936
B.S., Franklin and Marshall College, Lancaster, Pa., 1935

EXPERIENCE:

Edison Electric Institute, New York, N. Y., Coordinator, Educational Services, 1972 to present
State of New Jersey, Department of Education Coordinator, School-Industry Cooperation, 1960-72
State of New Jersey, Department of Education and The Thomas Alva Edison Foundation, Inc., Coordinator, Cooperative School-Industry Science Program, 1958-60
Rider College, Trenton, New Jersey, Professor of Science, Chairman of Science Department, 1948-58
Temple University Technical Institute, Philadelphia, Pa., Lecturer in Plastics, Air Conditioning and Refrigeration, 1946-48
Croasdale and de Angelis Plastic Fabricators, Upper Darby, Pa., Assistant to the Works Manager, 1945-46
Pioneer Instrument Service School, Bendix Aviation Corporation, Philadelphia, Pa., Instructor of Aircraft Instruments, 1944-45
Lower Merion High School, Ardmore, Pa., Teacher of Physics and Aeronautics, 1941-44
Prospect Park High School, Prospect Park, Pa., Teacher of Chemistry and Biology, 1939-41

AFFILIATIONS:
Liaison Representative for National Science Teachers Association with Education Activities Committee of Manufacturing Chemists Association, November 1970-March 1972.
Consultant for Mid-Hudson Career Development and Information Center, August 1971-February 1972.
Chairman of National Science Teachers Association--Allegro Advisory Committee for Science Screen Report, August 1971-February 1972.
President, Americans for the Competitive Enterprise System (ACES) June, 1972-.

Biographical Sketch

of

JACK L. SCHENCK

Mr. Schenck is Assistant Director, Economics and Statistics department, Edision Electric Institute, New York, New York.

BORN: August 2, 1938.

EDUCATION: BS in Electric Engineering from Michigan State University,

BA in Social Science from Michigan State University,

Graduate work in Economics at Wayne State University,

Currently completing thesis requirement for MBA in Corporation Finance at New York University.

EXPERIENCE: Engineering Assistant in an energy advisory team of the Agency for International Development which helped the government of Tunisia reorganize its electric power industry; 1961

Engineer in the Rate Division of the Detroit Edison Company; 1962-1963

Administrator in the Energy Division of the Organization for Economic Cooperation and Development (OECD); Paris, France; 1963-1969

Currently Assistant Director of Economics and Statistics and Secretary of the Institute's Rate Research Committee (see above); 1970-present.

Biographical Sketch

of

PETER VAN NORT

Mr. Van Nort is General Manager of the Project Management Corporation (PMC), Chicago, Illinois. PMC is a separate company established by Commonwealth Edison and the Tennessee Valley Authority to build the nation's first large-scale breeder reactor demonstration plant. As Project Manager, he was responsible for the design, development, engineering, research, schedule, budgets, licensing, environmental activities, and training associated with this demonstration plant.

BORN: Evanston, Illinois, July 13, 1937, and raised in Chagrin Falls, Ohio.

EDUCATION:

In high school, he was an all-state athlete, honor student and president of the student body. He attended the U.S. Naval Academy, where he was a varsity football and track man, Brigade Commander, and graduated eighth in his class, with a general Bachelor of Science Degree in 1959. From June through December, 1960, while employed by the joint U.S. Atomic Energy Commission (AEC) and Navy Department Organization, headed by Vice Admiral H.G. Rickover, responsible for the naval nuclear propulsion program, he completed the graduate level reactor engineering school run by the Westinghouse Bettis Atomic Power Laboratory for AEC.

EXPERIENCE:

Fluid Systems Engineer for the joint AEC and Navy Department Organization, 1959-61

Surface Ship Project Officer for the joint AEC and Navy Department Organization, March, 1962

New Construction Submarine Project Officer for the joint AEC and Navy Department Organization, January, 1963

Assistant Director for all training and personnel qualifications activities for the joint AEC and ND Organization, July, 1964

Senior Government Representative at the AEC-owned SIC facility, August, 1965

Nuclear Engineer for the Zion Nuclear Power Station of Commonwealth Edison, February, 1968

Nuclear Licensing Administrator for Commonwealth Edison, Aug., 1968

Area Manager of Northwest Area for Commonwealth Ed., Jan., 1970

Engineer of Mechanical & Structural Design for Com. Ed., Jan., 1971

Project Manager of Project Management Corporation (PMC), February, 1972 (see above).

Biographical Sketch

of

BURRELL L. WOOD

Dr. Wood is, at the present time, Special Assistant for Educational Programs in the Office of Information Services of the U.S. Atomic Energy Commission (AEC), Washington, D. C.

BORN: He was born in Cosby, Tennessee, but grew up in South Carolina.

EDUCATION:

After graduating from Clinton High School, he attended Presbyterian College where he received a B.S. degree in chemistry and a B.A. degree in French. He then attended the University of Georgia and received a M.S. degree in chemistry. He holds the Ph.D. degree in chemistry from the University of North Carolina. He spent one year in post-doctoral study at the University of Zurich, Switzerland, under a National Science Foundation Science Faculty Fellowship.

EXPERIENCE:

After one year as a research chemist with Taylor-Colquitt Company in Spartanburg, he taught six years at Presbyterian College, eight years at Furman University, and three years at New Mexico Institute of Mining and Technology in Socorro, New Mexico. He served as editor of Chemistry Magazine for Science Service in Washington, D. C., for one year.

Since coming with the AEC, he has served as Science Education Specialist in the Division of Technical Information; Chief, Research Information Analysis Section in the Division of Isotopes Development; Exhibit Coordinator in the Division of Special Projects; Overseas Exhibit Manager in the Division of Technical Information; Chief, Exhibits Operations Branch in the Division of Technical Information; Assistant Director for Exhibits in the Division of Technical Information; Deputy Director in the Organization for International Conference during the Fourth United Nations International Conference on Atomic Energy in Geneva, Switzerland; Environmental Education Specialist in the Division of Nuclear Education and Training.

Suggested Readings and Informational Sources

SUGGESTED READING LIST

This list of books, booklets and other publications is designed to provide additional balanced information concerning solutions to the energy dilemma. They can be obtained from the indicated sources, and from the FASST National Office.

THE ENERGY CHALLENGE: SELECTED OVERVIEWS

1. Energy and Power, a Scientific American Book.
2. Earth, Energy, and Everyone: World Game Studies Workshop, Earth Metabolic Design, 2016 Yale Station, New Haven, Connecticut 06520 (1974).
3. Managing the Planet Albertson & Barnett, Prentice-Hall, Inc., Englewood Cliffs, New Jersey (1972).
4. Energy Environment, and Productivity, National Science Foundation, Washington, D. C. 20006 (1973).
5. Exploring Energy Choices, Energy Policy Project of the Ford Foundation, 1776 Massachusetts Avenue, Washington, D. C. 20036 (1974).
6. Energy and the Future, American Association for the Advancement of Science, Washington, D. C. (1973).
7. Inventory of World Resources, Human Trends and Needs, World Design Science Decade: 1965-1975, Southern Illinois University, Document 4, Carbondale, Illinois.

ENERGY CONSERVATION

1. Waste Oil Recovery and Reuse, Information Transfer Inc., 1625 Eye Street, N. W., Washington, D. C. 20006 (1974).
2. Citizen Action Guide to Energy Conservation, Citizens' Advisory Committee on Environmental Quality, 1700 Pennsylvania Avenue, Washington, D. C. 20006 (1974).
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